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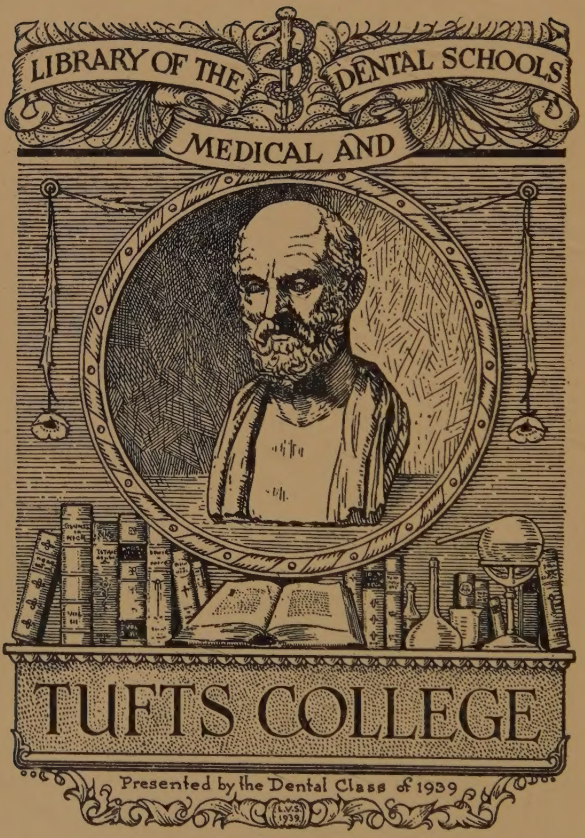
SYMPTOMS AND THEIR INTERPRETATION

FOURTH EDITION



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SYMPTOMS

AND THEIR INTERPRETATION.

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SYMPTOMS

AND

THEIR INTERPRETATION.

BY

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PREFACE

TO THE FOURTH EDITION.

WHEN, a dozen years ago, I wrote the first edition of this book, I dimly perceived that there was a field of medical knowledge essential to progress which was left almost unexplored. It might seem absurd to say that the field of symptomatology was in this state, for has not the study of symptoms been prosecuted since the dawn of medicine? Nevertheless, the more I have gone into this subject the more evident has it become that symptoms have *not* been properly investigated, and even the methods by which the investigation should be pursued have not yet been understood.

Though the value of symptoms has been recognised, yet the nature of their importance has not been clearly understood, and in consequence the

manner in which they should be studied was not guided by a definite object or on sound principles. Disease is only made manifest to us by the symptoms it produces, but when a man falls ill the function of every organ of the body may be disturbed, and did we possess the means an infinitude of symptoms would be discovered. As it is, new methods are continually being devised for the detection of new symptoms, and medicine is breaking up into an ever-increasing number of sections. Men are devoting much time to special subjects and using the resources of other sciences in developing their speciality. In this way, an ever-increasing number of symptoms are being revealed. This kind of research seems justified by the belief that because a new fact is discovered knowledge is progressing.

Whereas, the reverse is the case, for this kind of research only tends to defeat its object. In place of advancing knowledge, it actually hampers it by

clouding over the methods and the objects of the science of medicine, by an ever-accumulating mass of details. The progress of true knowledge is ever accompanied by a simplifying of the subject. This is because the laws of Nature are few in number. Details, with no understanding of the laws which govern their production, only lead to confusion. The discovery of the laws, on the other hand, tends to bring order out of the chaos by classifying the details according to those laws which govern their production.

This book is an attempt to find those laws, and by indicating principles to guide research on better defined lines.

J. M.

St. Andrews,
Scotland.
October, 1920.

January, 1921.

In the foregoing preface of this edition the need for understanding the laws which govern the pro-

duction of symptoms was dwelt upon, and it was then stated that this book was an attempt to find those laws. While the book was in the Press the search for these laws was being conducted by the staff of the St. Andrews Institute for Clinical Research. They have been successful in discovering that the principle governing the production of many symptoms is due to the disturbance of normal reflexes. This idea is foreshadowed in the book, and although it is impossible at this stage to tell the effect it may have on medicine in general, its application in practice and in research has already shown it to be of service.

The description of this theory, which appears in an Appendix at the end of this volume, was published in the *British Medical Journal* of 29th January, 1921, by whose kind permission it is reproduced.

CONTENTS.

CHAPTER I. Pages 1—10.

The Importance of Symptoms in Medical Practice and Research.

1. The science of medicine. 2. The importance of symptoms in diagnosis. 3. The importance of symptoms in prognosis. 4. The importance of symptoms in treatment. 5. The importance of symptoms in research.

CHAPTER II. Pages 11—18.

The Mechanism of a Diseasė Process.

6. Definition of disease. 7. The detection of disease. 8. Definition of symptoms. 9. Methods for investigating symptoms. 10. Principles of research.

CHAPTER III. Pages 19—29.

The Training of the Observer.

11. Medicine a science. 12. Accuracy of observation. 13. Clinical and laboratory observation compared. 14. Limitation of laboratory methods. 15. The importance of a clinical training. 16. The requirements of a clinical observer.

CHAPTER IV. Pages 30—39.

Principles of Investigation.

17. The need for principles. 18. Differentiation. 19. Classification. 20. The law of progression. 21. The law of associated phenomena. 22. The significance of symptoms (prognosis). 23. The use of laboratory methods. 24. The expectation of results.

CHAPTER V. Pages 40—47.

Classification of Symptoms.

25. The anatomical classification of disease. 26. The clinical classification of symptoms. 27. Structural symptoms. 28. Functional symptoms.

CHAPTER VI. Pages 48—56.

Reflex Symptoms.

29. The discovery of the seat of disturbance. 30. The discovery of the agent causing ill-health. 31. The discovery of the functions of the nervous system. 32. Methods of examination. 33. Mechanism of an ordinary stimulation. 34. Mechanism of the radiation of sensation. 35. Mechanism of a motor reflex. 36. Mechanism of radiation in disease.

CHAPTER VII. Pages 57—60.

Pain.

37. Definition of pain. 38. Constitution of the nervous system. 39. Difference in the functions of the two nervous systems.

CHAPTER VIII. Pages 61—73.

The Sensitiveness of the Tissues.

40. The tissues sensitive and not sensitive to mechanical stimulus. 41. Sensitive tissues of the external body wall. 42. Insensitiveness of the viscera to mechanical stimulation. 43. Methods for testing the sensibility of organs. 44. Testicular pain. 45. Artificial production of visceral pain.

CHAPTER IX. Pages 74—83.

Visceral Reflexes.

46. The mechanism of visceral pain. (The viscero-sensory reflex.) 47. The mechanism of the viscero-motor reflex. 48. Multiple reflexes from visceral stimulation.

CHAPTER X. Pages 84—96.

Diminished Resistance to Stimulation.

49. Focal. 50. General. 51. The soldier's heart. 52. War neurosis. 53. The mechanism of symptoms. 54. Practical importance of recognising the mechanism of symptoms.

CHAPTER XI. Pages 97—103.

Organic Reflexes.

55. Vomiting. 56. Dyspnœa. 57. Secretory reflexes. 58. Cardiac reflexes. 59. Vaso-motor and pilo-motor reflexes.

CHAPTER XII. Pages 104—113.

Preliminary Examination of the Patient.

60. The patient's appearance. 61. The patient's sensations. 62. Facial aspect. 63. The general condition. 64. A review of all the organs.

CHAPTER XIII. Pages 114—129.

Affections of the Digestive Organs.

65. The nerve supply of the digestive tract. 66. Distribution of sensory symptoms in affections of the digestive tract. 67. Appetite. 68. Hunger. 69. Nausea. 70. Mouth and fauces. 71. Tongue. 72. Swallowing. 73. Œsophagus.

CHAPTER XIV. Pages 130—154.

Affections of the Digestive Organs (continued).
The Stomach.

74. The nature of the symptoms. 75. The nerve supply of the stomach. 76. The site of pain in affections of the stomach. 77. The character of the pain. 78. Hyperalgesia. 79. Superficial reflexes. 80. Visceromotor reflexes. 81. Vomiting. 82. Pyrosis and heart-burn. 83. Air suction. 84. Functional symptoms. 85. Structural symptoms. 86. The diagnosis of stomach affections. 87. Pain in gastric ulcer.

CHAPTER XV. Pages 155—165.

The Liver, Gall-bladder, and Ducts.

88. Nerve supply. 89. Reflex symptoms in gall-stone disease. 90. Gastric symptoms in gall-stone disease. 91. The result of reflex symptoms. 92. Functional symptoms in gall-stone disease. 93. Structural symptoms in gall-stone disease. 94. Fever in gall-stone disease. 95. Nature of reflex symptoms in affections of the liver. 96. Functional symptoms in affections of the liver. 97. Structural symptoms in affections of the liver.

CHAPTER XVI. Pages 166—179.

The Great and Small Intestine.

98. Difficulties in diagnosis. 99. Pain. 100. Appendicitis. 101. Affections about the anus and perineum. 102. Perineal reflex. 103. Functional symptoms. 104. Structural symptoms.

CHAPTER XVII. Pages 180—195.

Affections of the Urinary System.

105. Symptoms of affections of the kidney. 106. Symptoms of affections of the pelvis of the kidney and ureter. 107. Symptoms of affections of the bladder.

CHAPTER XVIII. Pages 196—200.

Affections of Female Pelvic Organs.

108. The uterus. 109. The ovaries. 110. The vagina.

CHAPTER XIX. Pages 201—206.

Peritonitis and Peritoneal Adhesions.

111. Insensitiveness of the peritoneum. 112. Symptoms in peritonitis. 113. Symptoms in peritoneal adhesions (parietal). 114. Symptoms in peritoneal adhesions (visceral).

CHAPTER XX. Pages 207—221.

Affections of the Lungs and Pleura.

115. Nature of the subjective sensations. 116. The respiration. 117. Reflex symptoms. 118 Functional symptoms. 119. Structural symptoms. 120. Affections of the pleura. 121. Nature of the pain in pleurisy.

Chapter XXI. Pages 222—255.

Affections of the Circulatory System.

122. Heart failure. 123. The nature of the symptoms in heart failure. 124. Consciousness of the heart's action. 125. Breathlessness. 126. Viscero-sensory and viscero-motor reflexes. 127. The viscero-sensory reflexes in dilatation of the heart and liver. 128. The pain of angina pectoris is a viscero-sensory reflex. 129. Evidences of the viscero-motor reflex. 130. Organic reflexes. 131. Summation of stimuli the cause of angina pectoris.

Chapter XXII. Pages 256—274.

Estimation of the Value of Symptoms.

132. The relation of the symptoms to the general state. 133. Remote effects of the lesion. 134. Relation of symptoms arising from different causes. 135. The bearing of symptoms on prognosis. 136. The bearing of symptoms on treatment.

Index. Pages 276—308.

Appendix 309—332.

The theory of disturbed reflexes in the production of symptoms of disease, page 309.

LIST OF ILLUSTRATIONS.

PAGE

FIG. 1. Diagram of a simple reflex - - - - - 52

FIG. 2. Diagram of the radiation of sensation - - - - 52

FIG. 3. Diagram of motor reflex - - - - - - 54

FIG. 4. Diagram of radiation of sensation in disease - - - 54

FIG. 5. Diagram of the origin and distribution of the efferent autonomic nerve fibres - - - - - - 59

FIG. 6. The relation of cutaneous hyperalgesia to enlargement of the liver - - - - - - - - 67

FIG. 7. The relation of cutaneous hyperalgesia to gastric ulcer - - 75

FIG. 8. Diagram of an organic reflex - - - - - 76

FIG. 9. Diagram of a viscero-sensory reflex - - - - 76

FIG. 10. Diagram of a viscero-motor reflex - - - - 78

FIG. 11. Diagram of a combined viscero-motor and viscero-sensory reflex - - - - - - - - 79

FIG. 12. Diagram of multiple reflexes - - - - - 81

FIG. 13. Shows the areas in which pain is felt in affections of the digestive tube - - - - - - 116

FIG. 14. Shows the seat of pain, and the position of the gastric ulcer causing the pain - - - - - 149

PAGE

FIG. 15. Shows the seat of pain, and the position of the gastric ulcer causing the pain - - - - - - 151

FIG. 16. Shows the seat of pain, and the position of the gastric ulcer causing the pain - - - - - - 153

FIG. 17. Shows the region of cutaneous hyperalgesia after an attack of gall-stone colic - - - - - - 157

FIG. 18. Shows the region of cutaneous hyperalgesia after an attack of renal colic - - - - - - 185

FIG. 19. Shows the region of cutaneous hyperalgesia after an attack of renal colic - - - - - - 191

FIG. 20. Shows areas of pain and hyperalgesia in diaphragmatic pleurisy - - - - - - - 219

FIG. 21. Shows areas of cutaneous hyperalgesia in acute dilatation of the heart and liver - - - - - 238

FIG. 22. Area of pain and hyperalgesia in angina pectoris - - 240

FIG. 23. Area of eruption in a case of herpes zoster affecting the upper thoracic nerves - - - - - - 241

FIG. 24. Shows the area of cutaneous hyperalgesia after the first attack of angina pectoris - - - - - 243

FIG. 25. Shows the areas of cutaneous hyperalgesia after a number of attacks of angina pectoris - - - 243

APPENDIX. Figs. 1 to 8 - - - - - - - 309-332

CHAPTER I.

THE IMPORTANCE OF SYMPTOMS IN MEDICAL PRACTICE AND RESEARCH.

1. *The Science of Medicine.*
2. *The Importance of Symptoms in Diagnosis.*
3. *The Importance of Symptoms in Prognosis.*
4. *The Importance of Symptoms in Treatment.*
5. *The Importance of Symptoms in Research.*

1. The Science of Medicine.—There are many matters in medicine seemingly so simple that it is taken for granted that they are beyond further discussion or investigation. Of these matters, seemingly so simple, the symptoms common to ill-health are the most prominent. Ever since medicine was seriously studied symptoms have received attention, and the notion is firmly held by medical men, specialists, physicians and surgeons, and experts of all kinds, that the symptoms revealed by the doctor's unaided senses are so well understood that the information to be gathered from them has been exhausted, and that their further study is not necessary to the progress of medicine. Hence has arisen the belief that, for the progress of clinical medicine new methods are necessary for the further elucidation of symptoms.

This mistaken attitude towards symptoms is not only misleading, but hampers medicine in Practice and Research. Indeed, the importance of symptoms is so imperfectly realised that a description of the meaning, mechanism and significance of symptoms is nowhere to be found, and this constitutes a great defect in medical knowledge.

Although this defect in the knowledge of symptoms may be recognised, it is not easy to understand how it is to be remedied. This is due to the fact that, notwithstanding the strenuous efforts that have been made to advance medical knowledge, the manner in which medical science should be prosecuted has never been understood. It has been assumed that investigation in clinical medicine was a simple matter, and that anyone with the usual medical education was fitted to undertake research in medicine. It has never been recognised that for its research principles and methods are required which are different from those necessary to other sciences, and even from those used in other branches of medical science, while a long training of the investigator is necessary, of a kind rarely undertaken.

2. Diagnosis.—The urgent need for a better knowledge of symptoms can only be realised if the great defects in medical knowledge are recognised. The general practitioners are the people who are brought into contact with the illnesses which impair the health of the community. An analysis of the complaints which the general practitioner sees reveals the present state of medical knowledge. If we put aside the trivial ailments and consider the illnesses which lower the health of the great majority

of people, it is found that only a small percentage (5-10) are capable of being diagnosed with any degree of accuracy. Most of this small percentage are cases of disease so advanced that the organs are damaged beyond repair, such as apoplexy, chronic Bright's disease, gangrene of the feet, advanced heart disease; and these are the end results of a long period of ill-health, whilst the origin of the ill-health was not detectable. Even such diseases as consumption, and gastric ulcer, are in all probability secondary or superadded diseases—at all events, their diagnosis before gross changes take place cannot be made.

The backward state of diagnosis is illustrated in these two latter conditions. They are such common complaints and have been the subject of long and careful investigation by innumerable doctors, yet to-day we cannot detect consumption until the lungs are damaged, usually beyond repair, while, as regards gastric ulcer, Berkley Moynihan, out of his great experience, states that it is disheartening and humiliating to have to confess that at this time we are still often unable to detect this complaint.

To appreciate the significance of this lack of knowledge of diagnosis one has to see it in relation to the health of a community. In a town of 100,000 inhabitants 25,000 will likely consult doctors in one year. 5,000 may suffer from trivial complaints and accidents. Of the 20,000 only a small proportion will suffer from diseases that are diagnosable, on a safe assumption, 2,000. We have then, in a population of 100,000, 18,000 people ailing, of the nature of whose complaint we are still profoundly ignorant.

When the significance of these figures is grasped it will be seen that there is an urgent need for some method in the investigation of disease, different from that which has been pursued in the past.

3. Prognosis.— Prognosis is the judgment of the significance of symptoms as indicating the future course of the patient's complaint. A knowledge of this branch of medicine is absolutely essential to the intelligent practice of medicine, and it concerns everyone who has to deal with the sick. Before any course of treatment is taken it is necessary to understand whether the complaint is amenable to treatment. The fitness for the patient to do his work, or to live in a given place, all depends on a knowledge of prognosis. It is scarcely necessary to refer to its importance in regard to life insurance and the examination for military, naval, and government services.

A knowledge of prognosis can only be acquired by the detection of symptoms, and the ability to recognise whether these symptoms are the expression of a diseased state or a variation of the normal, indicative neither of disease nor of impairment, is required. When it is recognised that the symptoms are an expression of disease it is necessary to tell whether they represent a damage to the body which impairs its functions, and whether the damage is stationary or progressive.

The need for this kind of knowledge is readily visualised if some illustration be given by reference to well-established practice. Many eminent and experienced surgeons have seen disastrous results

from a delay in operating on appendicitis, so that they strongly recommend that all suspect appendices should be removed. The result of such a procedure is that a great many people are subjected to the operation when there is no disease of the appendix. This is simply due to the fact that medical knowledge has not advanced so far as to interpret correctly the symptoms of appendicitis, nor to understand their significance, so that large numbers are operated upon unnecessarily. Anti-toxin is believed to be such a potent remedy in diphtheria that, as a matter of routine, every one who contracts this disease is given it. We know that diphtheria in the great majority of cases is not a serious disease, yet because of an absence of knowledge of prognosis, the remedy is given indiscriminately to every one.

It will be said, of course, that in the cases of appendicitis and diphtheria it is impossible to fortell which case will become dangerous, but that is merely stating in another way the fact that medical knowledge has not yet advanced far enough to understand the prognostic significance of certain symptoms.

Not only has medical knowledge not advanced so far as to permit a prognosis in such instances, but it has not gone so far as to recognise either the importance of the subject or the manner in which the knowledge can be acquired. A little consideration will reveal that this knowledge can only come from long experience, yet in matters dealing essentially with prognosis, such as in life insurance examinations and in recruiting, a medical qualification is deemed to carry with it the ability to give

a prognosis, and young doctors with little experience are supposed to be capable of doing this kind of work.

When the real significance of a prognosis comes to be understood, the attitude of the profession to-day will seem amazing. There is no branch of medicine which requires so profound a knowledge of disease and its manifestations, a knowledge that can only come through long experience and painstaking observation of symptoms. But, so far, the profession have not yet awakened to the great defect in knowledge of this very important subject, and how little progress is being made in its development.

It is now more than 40 years since, as a young graduate I was permitted to examine a lady with a systolic murmur. It had been discovered accidentally by a distinguished Edinburgh physician, and he had ordered the patient to bed and prescribed digitalis, which she was taking in large quantities. She and her husband were warned of the danger of the heart conditions, particularly in regard to pregnancy. For a time a careful life was led, but gradually she resumed her old life, and lived for a great many years an energetic life. Although the murmur persisted, she is now well over 70 years of age and shows no sign of heart failure. A short time ago I was asked to see a youth, who had been confined to bed for three months because a physician attached to a large teaching hospital had detected a systolic murmur, which I had no difficulty in recognising as being physiological. This inability to recognise the prognostic significance of a murmur

is not exceptional by any means, and I place these two instances in juxtaposition to show how little progress has been made in 40 years in even such a simple matter as this. But one has evidences of this lack of progress everywhere, and nowhere more strikingly than in the matter of life insurance. The medical forms in regard to the circulation have scarcely altered, if at all, for over 50 years, as if medical science had not advanced since then.

Nor is there any prospect of advance in this important matter till a better knowledge of symptoms is acquired and it is recognised that the only person who can advance this kind of knowledge is one who has the opportunity of seeing the progress of disease in individual patients, watching them intelligently through complaints from start to finish.

4. Treatment.—Treatment which consists of the introduction into the body of an agent—drug, vaccine, serum, electricity, X-rays, radium emanation —produces reactions, often indistinguishable from the symptoms produced by certain diseases, as in patients with vomiting, diarrhœa, drowsiness, headache. Certain of these remedies act by removing a noxious agent, as by vomiting or purging, or by killing it, as mercury in syphilis. But the vast majority of remedies when they have any effect act by modifying the symptoms of disease. This is the justification for treatment—particularly in the case of suffering—to relieve the distressful symptoms. It will thus be seen how important is a knowledge of symptoms for the intelligent investigation of drugs or other remedy. The drugs which find a place in the pharmacopœia have never been studied from

this point of view, with the result that a great number of utterly useless drugs are included, while those which are of use have never been studied with that care and accuracy necessary to recognise the real effect of the drug on the diseased human being. Experimental investigation shows how a drug may act on healthy tissues, but drugs are not given to the healthy but to the sick who show symptoms of disease, and it is for the removal of the causes of the symptoms or for their modification the remedy is given. This is well illustrated by the use of digitalis. For 150 years the drug was known to have a beneficent effect in heart disease, but no clear conception of the kind of case existed, so that it was given indiscriminately to all patients who had, or were supposed to have, a cardiac affection. Many attempts had been made to find out its effect in the human heart, including experiments on animals, but it was not until the symptoms, particularly the abnormal rhythms, were recognised that its effect in the human heart was discovered, and the kind of case in which it acted beneficially was recognised.

The principle which guided to this discovery was the intelligent perception of the symptoms with a knowledge of their mechanism, and then the careful observation of the effect of the drug in producing or modifying these symptoms. Before an intelligent investigation into the action of remedies in the sick human body is undertaken a knowledge of symptoms is necessary.

5. Research.—There is to-day a recognition that medical knowledge is greatly lacking in many essentials, and strenuous endeavours are made for the encouragement and prosecution of research. Where a clear conception of the problem is attainable, an orderly and well-planned investigation may result in a successful issue, as in the investigation of malaria and allied diseases and syphilis. An absence of a clear conception of how research should be pursued leads to a disorderly attack on disease, and a great waste of time and energy is bound to result. The vast majority of diseases which afflict a community in this country have not been clearly recognised, so that any attempt to prevent or cure such diseases is sure to lead to failure. It is therefore manifest, before we can attempt to deal effectively with the more common diseases, a knowledge is first required of the manner in which these diseases affect the human body. While the study of how a noxious agent which produces disease, such as a microbe, may behave in culture media or in animals, may be necessary to the inquiry, yet a knowledge of how the noxious agent reacts upon the human body is also necessary. As this knowledge can only be acquired by the study of the reactions produced in the body, the importance of symptoms is apparent.

A wider view of research must also be taken. As already indicated, diagnosis, prognosis and treatment are essential to the practice of medicine. Research in these subjects is urgently called for. Such research can only be undertaken by those who have the opportunity of seeing individuals in ill-health, so that an investigation of the symptoms of

disease, carried out systematically and with a precision hitherto unattained, is urgently called for.

Investigators are recognising that they have only an experience limited to certain aspects of disease, and they find it necessary to associate themselves in bands or teams for the prosecution of research. Many of these teams include men profoundly informed in their particular branch, but there is one member essential to this work who is invariably absent—one with a knowledge of the symptoms of disease. The need of this type of investigator is recognised, and one with clinical experience is sometimes included in such a team, but medical knowledge has not yet advanced so far as to enable such an investigator to recognise that his knowledge of symptoms is so imperfect that he is unfitted for such work.

In the intelligent prosecution of medical research, therefore, a knowledge of symptoms is essential.

CHAPTER II.

THE MECHANISM OF A DISEASE PROCESS.

6. *Definition of Disease.*
7. *The Detection of Disease.*
8. *Definition of Symptoms.*
9. *Methods for Investigating Symptoms.*
10. *Principles of Research.*

6. Definition of Disease.— Before an attempt is made to investigate any phase of ill-health it is necessary to hold clearly in mind what disease is. Attempts have been made to give a logical definition to the term, but it has resulted too often in so many refinements that in the end confusion exists where clarity is required.

Apart from the original meaning of the word as signifying a lack of ease, the term disease, as commonly applied, refers to a distinct condition or entity. When, for instance, a patient suffers from pain in the eyeball and lachrymation, and the conjunctiva is seen to be red and injected, we recognise that he suffers from a disease, or a diseased state. An examination by one doctor may fail to reveal any further facts, and he would call the disease conjunctivitis. Another doctor may recognise that the symptoms of photophobia, lachrymation

and injection of the capillaries are phenomena produced by a foreign body acting on certain tissues of the eye, and may detect a speck of coal implanted on the cornea. The removal of the foreign body is followed by the disappearance of the phenomena.

Here we have a clear example of what constitutes disease, and from such an instance disease can be defined as "A state induced by an agent acting injuriously on the tissues."

The speck of coal by itself is not a disease, nor is the lachrymation and other signs. When, however, the speck of coal produces these signs the whole syndrome (agent and attendant phenomena) can be conveniently grouped under a definite term a disease.

When the ailments that affect the human body are carefully analysed it will be found that the vast majority conform to this definition of disease. The noxious agent may be a foreign body, a microbic infection, or chemical in its nature, all of them innocuous structures outside the body, but on their entrance into the body, as soon as they cause a re-action, a state of disease may be said to be produced.

In many people who suffer from ill-health the matter is much more complicated, but this is simply due to the fact that with the persistence and progress of the diseased state new reactions are set up until the number is so great that the original disturbance is lost sight of. Nevertheless, fundamentally, the onset of ill-health was provoked in the manner described in the definition.

7. The Detection of Disease.—In the simple illustration of the foreign body in the eye the noxious agent and its effect upon the tissues are readily seen and recognised. Unfortunately the cause of ill-health in the vast majority of cases cannot be so clearly elicited. The noxious agent is more subtle; its mode of entrance into the body is undetected and the original seat of disturbance obscure, and as a rule there is no direct evidence of its nature, so that seldom can a diagnosis be made based on its detection.

While the agent which provokes the ill-health is therefore not recognisable, the phenomena or the symptoms it produces afford the clue by which it may be detected. These phenomena vary widely, but they depend in the main upon two factors :—

(1) The nature of the noxious agent;

(2) The tissue acted on.

It is scarcely necessary to elaborate this point. The agent may be, as already stated, a foreign body, a microbe, or chemical in its nature, and it can be understood that the action of these different agents on the tissues would vary; while the tissues acted upon, as fibrous tissue, muscular tissue, nervous tissue, or secretory cells, would give reactions peculiar to their functions.

Direct detection of the noxious agent being often impossible, we are driven to seek for it by following up the clues afforded by the reaction of the different tissues, which in the human body we recognise as the signs and symptoms of disease.

8. Definition of Symptoms.—Much consideration has been given to the definition of the terms—signs and symptoms of disease. In this book no distinction is made between them. The terms symptoms, signs, manifestations, phenomena, are used interchangeably, and mean a *reaction of the tissues of the body to a noxious agent.*

9. Methods for Investigating Symptoms.—Recognising that symptoms are the reaction of the tissues of the body to a stimulus by an agent, for a due appreciation of their meaning certain of their features have to be clearly understood. A person in ill-health may present some readily detected sign, as pallor, or suffer from some sensation, as pain; and the custom has been, when the doctor has failed to find the causes of these symptoms, to diagnose the cases as anæmia and neuralgia. So long as such diagnoses satisfy it is manifest no progress can be made. No doubt there is a difficulty in getting beyond this step, and medical science has not yet advanced so far as to recognise the method by which further knowledge can be acquired.

The first step to be taken is to find the mechanism by which symptoms are produced. No doubt, many observers have attempted this study, and a limited advance has been made. The state of the blood has been the subject of much inquiry, and a great many facts have been accumulated. Likewise, pain has been the subject of much study, and again many facts have been accumulated, yet the results have led us on but a little way, and are scarcely commensurate with the time and energy spent on them. The reason for this comparative

failure is that we do not yet understand the principles which should guide research in medicine. If we take one of the commonest of symptoms, that of pain in disease of the viscera, and consider what information it is capable of yielding were it thoroughly investigated, we will understand some of the steps necessary to be taken for advancing our knowledge of disease.

Investigations have shown that the pain in disease of the viscera is referred to some portion of the external body wall, frequently remote from the seat of disturbance. The mechanism by which this is brought about seems to be as follows. A stimulus of a particular kind arises in an organ produced by some noxious agent. This stimulus passes by a sympathetic nerve to its cell in the central nervous system. There the stimulus passes from this cell to other cells in its immediate neighbourhood, and these cells, when stimulated, re-act according to their function, a secretory cell modifying the secretion, a muscular cell giving rise to contraction in its muscle, a pain cell producing pain referred to the peripheral distribution of definite nerves in the external body wall.

There is thus good reason for assuming that there is a relation, precise and definite, between the viscera and areas of the external body wall, through the nervous system. When this relation is better understood it will then be possible to say, when a patient complains of a pain in a definite region, in which organ the disturbance is which produces the pain.

The next step will be to recognise what tissues

of the organ are capable of giving rise to pain when stimulated. We do know that certain tissues may be subjected to much injury and destruction without pain, while other tissues readily cause pain when stimulated in a particular manner.

The last and most important step is to recognise the nature of the stimulus—it may be the noxious agent which is the cause of ill-health. We know that not all stimuli applied to an organ will give rise to pain. For instance, the cutting or tearing or burning of organs may occur and no sensation be elicited. Yet we do know that visceral disease is capable of giving rise to pain of all degrees of severity. Manifestly, then, it is only stimuli of a peculiar kind that are capable of producing pain.

Inquiry so far has revealed that there are probably but a few kinds of stimuli capable of producing pain, and that these can be differentiated in several ways, as by the character and duration of the pain, by the conditions that tend to provoke it, and by the presence of other phenomena, which have been provoked at the same time and by the same stimulus. It will be seen that this line of investigation holds out the expectation that pain and its associated phenomena may not only indicate the (1) site of the organ, (2) the tissues disturbed, but also (3) the nature of the agent producing it.

There is now sufficient evidence to show that specific agents on entrance into the body produce specific reactions. This is recognised in the case of the exanthemata, even though the agent has not been actually recognised in all cases. With a better understanding of the mechanism by which symptoms

are produced, and by the detection and correlation of associated symptoms, and the careful study of the conditions found post-mortem, or on the exposure of the viscera by operation, combined with bacteriological and other laboratory inquiry, the morbid state—provoking agent and reactions—will be elucidated.

10. Principles of Research.—The reasons for the foregoing definition of disease and of symptoms is that it helps to render clear the object to be aimed at in any investigation into symptoms. Hitherto much clinical research has been rendered ineffective because the different methods of inquiry have not been clearly visualised, and much time has been spent on the study of the nature of the symptoms and too little on their mechanism. The distinction seems, no doubt, subtle and slight, but it is fundamental. We see, for instance, that the peculiar features of such symptoms as anæmia, Cheyne-Stokes breathing, anoxemia, hyperchlorhydria, and albuminuria have been studied with meticulous care, but little has been done to understand the mechanism by which they are produced. In the study of pain the effects of the various drugs that relieve the suffering have been the main object, while the mechanism by which pain is produced has been so imperfectly studied that little real knowledge of this clamant symptom has been found. Yet, as I have said, it is a symptom which not only calls attention to the presence of disease, but if intelligently interpreted would lead directly to the organ affected, and even reveal the nature of the injurious agent producing the ill-health.

I frankly confess that I have but a dim idea of the method to be pursued in discovering the mechanism of many symptoms, but success has attended the inquiry in regard to some, and the principles which have guided to these discoveries will serve to direct the inquiries in our investigation of the others. These principles are dealt with in Chapter IV.

CHAPTER III.

THE TRAINING OF THE OBSERVER.

11. *Medicine a Science.*
12. *Accuracy of Observation.*
13. *Clinical and Laboratory Observation compared.*
14. *Limitation of Laboratory Methods.*
15. *The Importance of a Clinical Training.*
16. *The Requirements of a Clinical Observer.*

11. Medicine a Science. — Medicine has not attained that position in science which ought of right to belong to her. Instead of leading in scientific development, and giving guides and indications to allied branches, she is too often content languidly to follow in their wake, or to pursue some erratic course of her own. The observations made in her name are frequently made more to support some vague speculation or far-fetched theory than to realise the actual condition of the observed phenomena. The sister sciences, in place of seeking for assistance from medicine, look askance at the wild speculations put forth in the name of medical science, and at the loose thinking and play of the imagination which many medical writers deem legitimate in dealing with the phenomena of disease. To emancipate medicine from

this position of inferiority, and to secure for it that status which it ought to possess, an effort must be made, as far as possible, to free it from the habiliments that have hampered it in the past; and if this appears an unattainable goal at present, its votaries may at least aim at greater precision in thought and in observation. Although this doctrine may seem the commonest of platitudes, and teachers and writers of text-books are unwearied in inculcating it, nevertheless precision, in thinking and in observation, are among the rarest qualities.

12. Accuracy of Observation.— The power of accurate observation and precise thinking is seldom acquired, because methods have become so stereotyped that many observers do not realise that they are fettered in the bonds of tradition. Even in the writings of those who claim to be exponents of exact observation and logical reasoning, loose methods of thinking and observing too often appear, even when the scientist imagines himself supreme; for traditional teaching influences their minds and gives a bias to their deductions. What are called observations are often but a mixture of imperfect observation and unwarranted assumption. While a fact is supposed to be recorded, an opinion is at the same time expressed. As an illustration let us observe how the symptoms of a patient with an enlarged liver are often investigated. The position of the liver having been ascertained, pressure over it is found to elicit pain. The surgeon or physician proceeds to record the "fact" that the "liver is painful on pressure," and such a description is universally accepted as truthful. Yet, if the matter

be carefully analysed, the statement will appear not to be a fact at all. Had the statement been that the patient felt pain when pressure was made over the liver, then a plain fact might have been recorded, if the patient's testimony was reliable. But to say that the " liver was painful " is to make an assertion that may or may not be true, but which is not warranted by the evidence, seeing that pressure was being exerted on the sensitive structures of the external body wall, and no attempt was made to eliminate the possibility of the painful sensation being produced by their stimulation. This tendency to embody assertions, warranted or unwarranted, in the record of a fact is a fault common among medical investigators, and impedes the progress of medicine. An inquirer should keep his mind free from bias and ready to review his most cherished beliefs. What is to-day accepted as axiomatic may be shown to-morrow to be but a part of the truth. The tendency to be led by tradition is very powerful, and it is difficult to free the mind from beliefs that have been inculcated with the acquisition of knowledge. In consequence of this, many observations are fundamentally untrue, and only covered by a veneer of science.

There have been many stumbling-blocks in the path of medical progress. They are mainly due to the lack of understanding of the distinctive character of the science of medicine. The knowledge of disease is so incomplete that we do not yet even know what steps should be taken to advance our knowledge. It has been assumed that the methods which are suitable for various branches of science

—as chemistry and physics—should be applied to medical investigation, but the methods of these sciences are not applicable to the investigation of the most important phenomena of disease. The methods which have helped some sections of medicine—as physiology and bacteriology—are not applicable by themselves to the wider fields of clinical medicine.

The present-day conception takes too narrow a view of the field with which medical science has to deal. It assumes that instrumental methods are of necessity the only scientific methods. It has been assumed that because recording and measuring instruments and other methods have greatly advanced such limited fields of medicine as physiology, bacteriology, and chemistry, that therefore clinical medicine should adopt the same methods. In medicine there are phenomena which the scientific instruments of to-day, however delicate, can neither register nor measure, and there are methods necessary for the investigation of disease which no laboratory experience can supply.

As an outcome of this misunderstanding, large fields for investigation which are essential to the progress of medicine have been ignored, methods and principles have been unrecognised or imperfectly applied, while the appropriate investigator has been neither trained nor encouraged to do the work which he alone has the opportunity to perform.

13. Clinical and Laboratory Observation Compared.—It is necessary to grasp fully what is required of a trained clinical observer, because to-day the essential qualities to a great extent have been lost sight of. This has arisen through an imperfect

conception of the requirements for clinical observation. Methods that have been found suitable and necessary for other sciences have been introduced, and have been substituted for those that are essential and peculiar to clinical medicine. Men are now recommended to go into laboratories devoted to one or other of the branches into which medicine is split up, and are trained in methods that are supposed to be more exact and scientific than the clinical methods. This view is the one dominant to-day, so that we find preference given to men trained in this way in all matters concerned with research, and even in the teaching of medicine. This practice is based upon a misunderstanding of what clinical observation requires and what clinical research means, and it leads directly to incompetence of the laboratory-trained man as a clinical observer and as a clinical investigator.

A very brief consideration will render this apparent. The physiological laboratory is assumed to be the most scientific of all our branches, and a training there is supposed to qualify a man for research in medicine. An experiment is performed which produces a reaction which an instrument can record. This record is carefully studied, and certain conclusions—which may be of value—are drawn. From a great many experiments of this kind a large increase of valuable knowledge has been obtained. The success and usefulness of this method is undoubted, but its success has blinded people to its limitations as a method to be applied in clinical medicine. Each of these experiments produced a great many more reactions than the one recorded, but as these

reactions were not capable of being recorded by an instrument they were ignored. The result is that a laboratory-trained observer cannot recognise any sign except those of a grosser kind, while the subtler and more elusive signs pass unrecognised. It therefore happens that the result of an experiment is only partly recognised. The clinical observer is like the physiologist in this respect, that both are searching for a reaction to a stimulus. In physiology the stimulus is artificial; in clinical medicine it is natural, or the result of disease. In both cases a variety of reactions follow the stimulus. The grosser reactions are only noted by the physiologist, and he has no means of detecting the subtler. In clinical medicine the grosser kinds have also to be detected, and the laboratory-trained observer can detect them, but his training has not enabled him to detect the subtler reactions, and hence he fails to attain that skill in observation which is essential to the clinician.

14. Limitation of Laboratory Methods.—The bulk of the most instructive phenomena produced by disease are incapable of detection by mechanical aids. Many valuable signs are only perceptible to the trained eye or the trained ear or the trained finger. Still more valuable signs are only revealed by the sensations experienced by the patient. To interpret these requires a training that can only be acquired by many years of patient observation, during which the mind is stored by the experiences of the past, by methods which are peculiar to medicine. These methods can never be acquired by a laboratory-trained observer, and it is because of

this that men trained in the laboratory fail as clinical investigators, however distinguished they may be as physiologists, chemists, or bacteriologists.

15. The Importance of a Clinical Training.—Before we can make progress towards the solution of any problem there are certain preliminary steps to be taken. The first is the perfecting of the instruments to be used. Before a man shaves he first sharpens his razor. Before we undertake an investigation we must see we have the appropriate implements. One implement essential to the success of our enterprise is a trained observer. It is scarcely realised what a difference there is between a doctor who has systematically trained himself to observe, and another who has perfunctorily examined his patients without attempting to improve his powers of observation. This can be shown in a simple matter like the feeling of the pulse. Many experienced doctors fail to detect irregularities except when very marked. Some physicians will recognise every beat in an irregular pulse; others will fail to detect a large proportion of the beats. Indeed, so common is the inability to count the beats in certain cases that I view many observations with a good deal of suspicion. Certain steps are necessary to train an observer so that he can acquire the ability to detect the peculiarities of the pulse, and to recognise their significance. He must, for instance, have seen a large number of cases, and studied them with great care, so as to correlate the sensations of his fingers with the result of observations made by his other senses. Thus he must correlate the pulse peculiarities with the sounds of the heart, with the movements

of the apex and of the jugular veins, and with the character of the sphygmogram. The significance of the pulse can only be recognised by watching the patient for long periods to ascertain what happens to him, and the variations that take place in the pulse and in the other symptoms as the case progresses have to be observed.

The same methods are necessary to train the other senses. A glance at the face will often reveal a great amount of information to the trained observer. Consider the years of study and observation that have been necessary to acquire that knowledge—a kind of knowledge essential to medical investigation, and impossible to acquire by the use of instruments however scientific.

It is now well recognised that the symptoms provoked in the early stages of disease are mainly subjective. There are a number of these sensations, and it is evident that, if the early stages of disease are ever to be recognised, the nature and significance of these sensations will have to be understood. There is, unfortunately, a widespread belief that all the information that the patients can yield is easily acquired, and it is generally supposed that the information is often so misleading as to be of little value. Moreover, the belief has obtained that abnormal signs revealed by an examination of the patient, especially by the use of an instrument, are of much greater importance, so that practically all the instruction at the schools is devoted to the study of physical signs. This is a great mistake, and is the chief reason why the knowledge of the early stages of disease is so defective.

This aspect of medicine is brought out if the sensations which indicate the onset of disease be considered. Most patients, when they fall into ill-health, become conscious of it by the fact that they are easily exhausted—exertion which they used to undertake with ease and comfort now renders them tired. The questions that arise are: "What is exhaustion?" and "what is the mechanism of its production?" Put in that way it will be recognised at once how little we know of this important symptom. An inquiry which I have been making for a number of years has led to a limited knowledge, and I can recognise that this sensation can arise from a number of causes, and where the condition of the patient is carefully investigated it will be found that this sensation of exhaustion can be divided into a number of different kinds.

The same careful training is necessary for the investigation of the most clamant of all symptoms, that of pain. To understand the full significance of pain in any case we have to know a great many matters which are still hidden from us. The tissues capable of producing pain, the nerves in whose distribution the pain is felt, the manner in which the pain spreads, and the laws governing the spread of pain; the character of the pain itself; the manner of its onset and its variations, and the phenomena with which it is associated, are all matters which it is necessary to understand before we are qualified to undertake an investigation into disease. So with all other sensations.

It is manifest that before a patient's sensations are understood the doctor must have a knowledge of

the mechanism of their production and of their significance. As a rule, the patient is merely concerned with detailing the sensation which troubles him most. It rests with the doctor to obtain by means of judicious questions the particulars of the different sensations. But the doctor cannot ask the proper questions unless he has sufficient experience and a knowledge of the nature of the sensations.

It will be gathered from this that the physician who would undertake the investigation of the early stages of disease must not only be a man of very wide experience but must have trained himself to observe on lines that have hitherto received little attention. The training, amongst other things, must have included the watching of patients for long periods to see the outcome of the complaint. If this is grasped it will be understood how vain it is to expect the early stages to be revealed in hospitals, where the custom is to hand the out-patient department over to the junior physician, who lacks that experience which should make him a competent examiner. I have for many years been calling attention to this error in education and showing how it hampers practice and research.

16. The Requirements of a Clinical Observer.—To qualify a man to be a skilled investigator in bacteriology, in physiology, and in chemistry, many years of special training are necessary. If it be realised that before a man is qualified to undertake, on the lines laid down, an investigation for the prevention and cure of disease—the real object of medical research—he must have a knowledge of symptoms, it will be seen that a training is required

which is bound to take a great many years. It is curious that men see the necessity for this in bacteriological, physiological, and chemical research, and will undergo the training, but so far the necessity has not been recognised for such a training before undertaking research in clinical medicine.

It is necessary to recognise that a competent observer must ever be learning. When face to face with patients and unable to detect the nature of their ill-health, he must not say that the disease is not capable of recognition, but rather say that the signs of disease are there, but he is incapable of detecting or understanding them. This is a humiliating confession, but a salutary one, for the recognition of a lack of knowledge is the first step to making that defect good.

CHAPTER IV.

PRINCIPLES OF INVESTIGATION.

17. *The Need for Principles.*
18. *Differentiation.*
19. *Classification.*
20. *The Law of Progression.*
21. *The Law of Associated Phenomena.*
22. *The Significance of Symptoms* (*Prognosis*).
23. *The Use of Laboratory Methods.*
24. *The Expectation of Results.*

17. The Need for Principles.—An investigation to be systematic and orderly must be guided by principles clearly defined. There are certain simple principles which are useful in making observations on disease. These principles are but provisional, but they may be a guide until the knowledge they reveal is exhausted, by which time an insight into research and what is wanted will be gained, and these principles can either be added to or supplanted. It must be recognised that in this work all are but learners, and while the steps taken to-day may seem very important and the discoveries may bulk largely in our visions, as time goes on their place in the perspective may be very small. First steps are always feeble and uncertain, but they are a necessary prelude to the vigour of full achievement.

These principles have no doubt been in use during the whole history of medicine, only they have been so imperfectly appreciated and applied that their significance has been overlooked.

These principles are:—

First, the clear differentiation of symptoms;

Second, the classification of symptoms;

Third, the employment of the recognition of a new fact as a foothold for further advance (the law of progression); and

Fourth, the search for other symptoms (the law of associated phenomena).

18.—Differentiation.—Having detected a symptom, whether subjective or objective, it is necessary to separate it clearly from all others that it resembles. This proposition is so self-evident that it seems unnecessary to dwell upon it, yet its significance has not been appreciated. The importance of this step was forced upon me many years ago when I began an inquiry into the significance of irregular heart action. I had not gone far into the study of the subject before I recognised that there were different kinds of irregularity, and though others had also, no doubt, recognised this, no one had attempted to differentiate them with any degree of accuracy on a rational basis. It is manifest that no progress in the knowledge of the meaning and significance of heart irregularities could be made until each form was clearly differentiated. This inquiry I undertook, and was able to found a differentiation based upon the mechanism of their production.

But in this inquiry I found that differentiation means more than the mere recognition of the mechanism of production. A differentiation based on the mechanism rarely leads to a recognition of the significance of a symptom. We know, for instance, that physicians have for long differentiated the murmurs of the heart on the basis of the mechanism of their production, but not knowing how to carry the inquiry further they left the matter there, and a misunderstanding of the significance of the murmurs has resulted. We know to-day how widespread is the misinterpretation of the significance of murmurs, and what injury has been and is being done to the individual patients and to the progress of medicine because of this limited differentiation.

Medicine calls imperatively for a further differentiation—one based upon the significance of the sign in its relation to the progress of the disease that produces it. A murmur may be differentiated according to the valve orifice at which it arises, but it is necessary that it should also be differentiated by the effect its cause has upon the functional efficiency of the heart. This will at once be seen to be of the first importance, not only in the practice of medicine but also in the pursuit of all kinds of research in which the heart is concerned.

Some years after I had begun the investigation of irregular heart action, other investigators took the matter up and helped greatly to determine the mechanism by which they were produced; but I was struck by the fact that they all stopped there, and practically no one but myself undertook the far more difficult task of differentiating them so as to

determine their significance. This could only be done by applying certain principles of investigation which are essential to medical research. These will be described later.

It is necessary to insist that we should always keep in mind that not only have we to detect the symptoms of disease, but we must differentiate them clearly on two principles—one on the basis of the mechanism of their production, the other on the bearing they have on the patient's future.

19. Classification.—The accumulation of symptoms is so bewildering in their numbers and complexity that it seems impossible to obtain a clear and simple comprehension of their significance. So long as what is called research is but the addition of new symptoms and of new methods for their detection, it can safely be said that little progress will be made in our knowledge of the fundamental principles of research.

A classification based upon Nature's laws tends towards simplicity and a fuller understanding. Such a classification I have attempted, and although I am far from stating that it fulfils all the requirements, it is nevertheless of distinct practical use, and as it is based upon natural laws it leads us to a clearer understanding of symptoms. Later I give a classification of symptoms showing they can be divided into three groups, according to the mechanism of their production, namely :

1. A *Structural group.*
2. A *Functional group.*
3. A *Reflex group.*

I pointed out, in dealing with differentiation, that, in addition to a differentiation based on the mechanism of a symptom, another sort of differentiation is required showing the significance of the symptom. For instance, when we recognise a sign due to a structural alteration, whether it be a change in the size or shape of the organ or a modified sound of the heart due to a deformed valve, it should be recognised that the knowledge obtained from the mere recognition is extremely limited. What is required to know is—what effect has the cause of the sign upon the patient's future? This question, which should be applied to the consideration of every symptom, cannot be answered by the study of the symptom alone, we must look for other signs, being guided in our search by the natural question, whether the functional efficiency of the organ is affected. Thus we are guided to seek for evidence of the second group of symptoms.

There are a great many diseases in which we fail to detect any structural sign or any functional impairment, yet we can recognise the disease with great accuracy. Most cases of gastric ulcer are recognised by such signs as pain, tenderness of the skin of the epigastrium, and hardness of the upper part of the recti muscles. There may be no structural sign nor sign of functional disturbance. Such symptoms are produced by an irritation of a limited portion of the central nervous system in a reflex manner, the source of irritation being in the ulcer.

While these groups form the basis of a classification, there are combinations of symptoms

which give occasion for further grouping and subdivision, which will be discussed in Chapter V.

20. The Law of Progression.—For many years no advance has been made in the use of many methods, such as the thermometer or the stethoscope. These and many other instruments are of the greatest use in clinical medicine, but it has been assumed that the limits of their usefulness have been reached. As a matter of fact, the clinical significance of the information which they yield has only been partially understood.

This restricted use has arisen because the laws governing research have not been understood. There has been a desire to improve a method, but it has not been recognised how it could be done. This has usually taken the form of modifying the instrument, as in the different forms of stethoscope that have been evolved. No doubt much benefit has resulted by perfecting the X-ray methods and laboratory methods generally, but the progress has rarely been commensurate with the time and trouble spent, because it has not been guided by an understanding of the principles of clinical investigation.

The discovery of a new fact or a new method must not be the end of the inquiry which has revealed it. Rather must it be looked upon as a means to an end, a stepping-stone to help a further advance. Medicine has failed fully to appreciate this aspect, chiefly because it was not understood how progress should be made. If the path had been clearly indicated, a forward movement

would have been made in many instances where our knowledge has stood still, as in the signs discovered by the stethoscope.

The chief causes that have hampered progress are the failure to recognise the necessity for understanding the prognostic significance of symptoms, and the lack of understanding of how this knowledge can be acquired.

21. The Law of Associated Phenomena.—One principle of supreme importance for the advance of medicine is the law of associated phenomena. This law is based on the fact that ill-health is always accompanied by a number of symptoms, and in every case it is incumbent upon us to search for other symptoms besides those which are most prominent. When, for instance, we detect a structural symptom, we must recognise the limited knowledge it reveals, and we must extend our observation and seek for signs of functional derangement. If we detect a sign and recognise it as the product of reflex stimulation, we are at once given a suggestion for further inquiry, and we must search for other signs which will lead us to the area of stimulation. The discovery of this area will lead us to the organ at fault, and it may be to the nature of the condition that provokes the reflex, and thus we get nearer the actual disease.

A very little study will soon bring conviction of the necessity for constantly keeping this law in mind. From the simplest complaint, a headache or a cough, to the most obvious physical sign indicating gross changes, the due appreciation of the case will depend on the application of this law.

22. The Significance of Symptoms (Prognosis).—The law of associated phenomena is necessary to the understanding of another main objective. It is necessary to find out the effect the cause of a symptom has on the patient's future—that is, prognosis, a part of medical science which lies at the foundation of the intelligent practice of medicine. To do this, contact must be kept with the patient during the remainder of his life or for the duration of his ill-health, and in doing this a look-out must be kept for the modification of the symptom and the development of new symptoms—that is, the detection of all associated phenomena.

It is only by this method that the early stages of disease can be detected. At first we may have no true conception of the cause of a symptom we may detect in an individual, but in course of time, as the disease develops, we may be able to recognise it. By referring back to our notes we will see how the symptoms were developed, and thus acquire a knowledge of the early stages. By finding similar symptoms in other patients later we may be able to detect the disease earlier, and so back to the beginning. Naturally in this way the prognostic significance will also be revealed.

23. The Use of Laboratory Methods.—The principle which should guide clinical investigation is first to recognise and understand the symptoms of disease, then endeavour to find out the agents producing the disease. Many of the symptoms will not be recognisable by the unaided senses, so in applying the law of associated phenomena

mechanical and other laboratory methods should be employed such as are found in a chemical laboratory and an X-ray department.

So many diseases arise from bacterial invasion that no method of research into the cause of disease would be complete without a skilled bacteriologist. An endeavour should be made to find out the nature of the symptoms provoked by the different bacteria. We recognise by the clinical symptoms the occurrence of a great many infectious diseases, where the specific microbe has been discovered, as typhoid fever and pneumonia. The recognition of other diseases is dependent entirely on the clinical symptoms, as measles and scarlet fever. We infer that the symptoms produced by other microbes may give rise to specific symptoms, and we can use this idea as a guide in one field of research. It is manifest that bacteriology must be greatly hampered until the symptoms of invasion are related to the infective agent causing the ill-health.

24. The Expectation of Results.—True clinical investigation holds out no expectation of results in the immediate future, so far as achieving the chief aim in medicine—the prevention and cure of disease. A long and weary road has to be travelled by those who would make clinical medicine an object for research. The training alone requires many years of patient toil, and the practice of setting young men fresh from the schools to undertake research in clinical medicine shows how little the subject is understood.

Such a contemplation of clinical research seems discouraging, for we all like to see the fruits of our endeavours. But it must be borne in mind that all great enterprises are based on work that has been done by individuals whose part is lost in oblivion. Someone has to do the obscure but necessary work of digging a foundation, and whoever undertakes this kind of work must be content with the knowledge that he is playing a necessary part in a great enterprise.

CHAPTER V.

CLASSIFICATION OF SYMPTOMS.

25. *The Anatomical Classification of Disease.*
26. *The Clinical Classification of Symptoms.*
27. *Structural Symptoms.*
28. *Functional Symptoms.*

25. The Anatomical Classification of Disease. It is a matter of knowledge common to every general practitioner that an explanation of the complaints of a large majority of his patients cannot be found by reference to any textbook. The cases he can recognise according to textbook descriptions are mainly those where the disease has reached an advanced stage, as in dropsy from heart disease, and consumption after the lungs break down, or when some terminal affection such as apoplexy occurs. In consequence the doctor is often at a loss what name to give the complaints from which his patients suffer, and he has to resort to the substitution of symptoms in place of the real cause, so that we get names such as neurasthenia, gastralgia, hyperchlorhydria, angina pectoris, tachycardia, albuminuria, which convey no definite information. The reason for this is that the classification of diseases is not based

upon a true knowledge of disease. It is the outcome of the time when pathology was dominant. With the introduction of accurate methods of observation, the nature of the diseases found after death was clearly demonstrated, and a classification of the different diseases that affected the different organs was made. This classification was so precise and definite, and seemingly so accurate and scientific, that it was adopted not only by the pathologist but by the clinician. The latter used this classification as a guide to search for and explain the physical signs which he detected in the living patient, and thus this classification became the standard for clinical medicine.

For a long time this seemed quite satisfactory, and was of value, but time has shown that for the practice of medicine it is not only faulty but misleading, in that it diverts attention from the real causes of disease and from the more important symptoms—those that are not included in what are called physical signs.

The need for a presentation of disease which describes the phenomena in the living human being is urgently called for, and an endeavour is made in the following pages to meet this need.

I have already pointed out that there has been no orderly arrangement of the large mass of symptoms which have been recognised. So long as facts are accumulated with no orderly arrangement the progress of medicine will be hampered and matters essential to its progress will be

obscured. I have therefore attempted a classification which is simple, yet helps greatly in understanding the nature of symptoms. This classification of symptoms is based upon the mechanism of their production.

26. The Clinical Classification.—In searching for a basis I have adopted one which in my present state of knowledge fulfils certain essential requirements, inasmuch as it is based upon natural laws, and gives at the same time information of a kind that is necessary in practical medicine, while its application guides one to an efficient examination of the patient.

To understand on what basis a classification of disease should be made we have to consider the manner in which symptoms are produced. Disease, where it impairs the health of the body, is due to a noxious agent producing a variety of phenomena or symptoms. Some of these may result from the agent, causing *a structural change in the tissues*, producing what is called a physical sign of disease. In every case of impaired health, the agent acts, directly or indirectly, upon the organs, *causing a disturbance in their function.* Such disturbances may be more evident than the structural signs or the agent of disease, and because of their prominence they may be mistaken for the disease itself. Amongst these disturbances of organs there is one class so distinctive and peculiar in its mechanism that it can be separated into a group by itself, particularly as its function is in many cases protective. The symptoms of this class arise from *stimulation of the central nervous*

system, and their appearance is often the first to direct attention to the fact that the individual is ill, and they also indicate the source of the trouble.

Taking the mechanism of their production as a basis, symptoms can thus be classified in three groups:

(1) Structural symptoms.

(2) Functional symptoms.

(3) Reflex symptoms.

27. Structural Symptoms.—Before we can detect a change in an organ we must have a knowledge of its position, its shape, and size, and other characteristics as revealed in the healthy body. A deviation from what we recognise as its appearance in health is called a physical sign, and physical diagnosis is the term applied to the detection of disease by the presence of these signs. It is necessary to hold clearly in mind what is revealed when we detect a physical sign, either by the unaided senses, or by means of the many mechanical means employed. In the main, a physical sign is due to an alteration in the structure of the organs; though in this class is included also such signs as the modification in the sounds and movements of the heart, and altered sensations. The detection of a physical sign gives little information beyond the fact that a change has taken place in an organ. There may, from experience, arise a knowledge that certain signs are associated with conditions of a definite nature bearing upon the health of the patient, as an enlarged heart is often associated

with heart failure, or a malignant tumour is accompanied by ill-health ; but, properly speaking, the signs of heart failure and impaired health are not revealed by the physical sign. It might seem to be a needless refinement to insist upon such a distinction, but for the purpose of keeping clearly in mind the limitations of knowledge revealed by a physical sign, such a distinction is necessary, for we find that in practice the detection of a physical sign is often thought to convey information far beyond what it actually reveals. Thus for the last 100 years the detection of a murmur in the examination of the heart has led to the assumption that the heart was seriously affected, and we see to-day how this view misleads the profession.

This failure to appreciate the significance of a physical sign is found in connection with most diseases. The detection of an impaired percussion note, or of a shadow in the lungs revealed by the X-rays, is judged to be sufficient evidence for a prolonged course of treatment. Totally unnecessary fears are frequently raised by the findings in an X-ray examination, or by other instrumental methods.

The limited knowledge and the peculiar kind of knowledge revealed by a physical sign must always be kept in view, as the neglect of this misleads, particularly in the use of mechanical devices in the detection of symptoms, as I shall point out later. Another matter to be kept in view is that a physical sign, due to some structural alteration in an organ, may be the result of a functional disturbance of another organ, as in

the eye signs and circulatory disturbances in disease of the thyroid gland.

28. Functional Symptoms. — The essential matter in the maintenance of health is the functional efficiency of the organs of the body. A structural modification may take place and leave the efficiency unimpaired. Thus it arises that after the detection of any physical sign, a careful inquiry must be made into the efficiency of the affected organ. The evidences of function are not always easy to detect, but it may be taken for granted that the disease of any organ will never be properly recognised until the function of the organ, and the part it plays in maintaining the health of the body, is understood. While a certain amount of knowledge may be obtained by studying the activity of the organ during health, a far better understanding will be obtained by studying the modifications of functions. These modifications can only be recognised by detecting the manifestations they produce on the body—*i.e.*, functional symptoms.

Functional symptoms are rarely detected from direct evidence in the organ affected, but rather from the effects produced on other organs. This is seen in its simplest form in certain affections of the thyroid gland. The structural signs give no indication as to the serious or simple nature of the affection; this is only found out by the effect of the perverted activity of the gland upon the heart, eye, and nervous system, and in the increased oxidation of the tissues. Diminished functional

activity, as in myxœdema, is shown also only by its effects on remote organs and tissues.

Even in an organ like the heart, whose condition and activity can be so easily studied, the information essential to a knowledge of its condition can only be made out by the reaction on other organs. The study of its various manifestations gives no idea of its functional efficiency, and this knowledge can only be acquired by observing how the circulation is maintained in other organs, as shown by dropsy or enlarged liver due to heart failure. Even in the early stages of heart weakness, the essential signs are brought about by a failure of the heart to supply sufficient blood to remote organs.

In affections of the kidney, the symptoms essential to a knowledge of the state of the kidney are not elucidated by an examination of the kidney, and even the elaborate chemical and microscopic examination of the urine fails to yield information so important as the presence or absence of changes in the heart and blood vessels.

It will be seen that not only do organs remote from the original disease exhibit the essential symptoms produced by depraved function, but organs thus affected in this secondary manner may show such signs from this cause that they form the principal feature in the picture of impaired health. Indeed, it will be found that a great many diseases, which are described as independent and distinct, are but the reaction to the depraved function of another organ. This is best seen in

the response of the heart. Probably the depraved function of every organ reacts upon the heart, either through the nervous mechanism of the heart, or from its nutrition being impaired, as in anæmia.

The importance of recognising this class of symptoms as distinct is because it gives a line of investigation in each case. Already we know of many symptoms produced by different organs which are associated in their appearance, and we recognise certain groups of symptoms as being due to the altered or impaired function of an organ, so that the appearance of one of a group leads to a search for others. Moreover, the increase in our knowledge of the mechanism of the individual symptom will inevitably lead to a better understanding of the organ whose depraved function is the cause of the disturbance, and thus contribute largely to that very necessary branch of knowledge—the pathology of function.

It might seem unnecessary to point out how important this view is from the standpoint of treatment. It is manifest that if such an organ as the heart is disturbed by the depraved functions of other organs, any treatment which is devoted to the heart will be useless. Yet this view needs emphasising, for to my knowledge, large numbers of individuals are submitted to prolonged treatment for cardiac symptoms in which the organ is only secondarily affected. Indeed, so important is this aspect of the matter that the question should arise in connection with every disease, whether the symptoms are not manifestations of a disease provoked by some other organ. The importance of this point of view will be more fully considered later.

CHAPTER VI.

REFLEX SYMPTOMS.

29. *The Discovery of the Seat of Disturbance.*
30. *The Discovery of the Agent causing ill-health.*
31. *The Discovery of the Function of the Nervous System.*
32. *Methods of Examination.*
33. *Mechanism of an Ordinary Stimulation.*
34. *Mechanism of the Radiation of Sensation.*
35. *Mechanism of a Motor Reflex.*
36. *Mechanism of Radiation in Disease.*

29. The Discovery of the Seat of Disturbance.—I have already remarked that much valuable time is often spent in research work which fails to achieve results at all commensurate with the labour devoted to it. One half of the battle in all research work consists in having a definite object, with a clear conception of how the object is to be achieved. The study of reflex symptoms leads directly to the organ at fault, and may discover the agent causing the ill-health. The inquiry into the nature of reflex symptoms has not only helped in the discovery of facts of great value, but has revealed the methods by which other objects essential to the progress of medicine may be pursued. It has demonstrated,

for instance, that there is an intimate relation between the organs and definite areas of the skin, or rather between the organs and the distribution of the sensory nerves in those areas, and between the organs and parts of the skeletal muscular system. A knowledge of this relation at once reveals which organ is at fault. When we detect sensory disturbances—pain or hyperalgesia—in these parts, or when we find a persistent contraction of the muscles, we are able to relate these to a definite structure within the body. In this way we seek to link up the organ with the disturbed region in the external body wall. This can be accomplished by the careful examination of the disturbed regions and correlating them with the disease discovered on the operation or *post-mortem* tables.

30. The Discovery of the Agent causing Ill-health.—In addition to the discovery of the organ at fault, we have the opportunity of discovering another very important matter—namely, the nature of the stimulus which is capable of producing these disturbances in the external body wall. It requires a stimulus of a peculiar kind to produce these reactions. Some disease processes produce one form of reaction and others produce other reactions. The careful noting of the different reactions and their correlation with the disease process will reveal the nature of the stimulus which may be acting, and so we get, at a very early stage, from the symptoms produced in the external body wall, a sure indication not only of the organ at fault but of the kind of disease present in the organ.

31. The Discovery of the Functions of the Nervous System.—The recognition of the phenomena produced by reflex stimulation by disease will be found to open new fields of investigation in the central nervous system. The radiation of stimulation, for instance, shows there are paths in the central nervous system hitherto unrecognised. The peculiar fields of cutaneous hyperalgesia and of the radiation of pain in diseases of such organs as the heart, gall bladder, ureter, and bowel, shows that the stimulus entering the central nervous system pursues a very definite course. This is also seen in the area of cutaneous hyperalgesia in renal colic, as represented in Fig. 18, page 185.

In addition, it is only by the study of these symptoms that a full knowledge of the afferent system of the nerves belonging to the involuntary nervous system can be acquired.

32. Methods of Examination.—As we know, ill-health leads to the production of a great variety of symptoms, and we also know that some simple cause is capable of producing these symptoms. The trained investigator may detect the cause in a variety of ways—by the intelligent questioning of the patients as to the onset of their ill-health and their sensations, by the recognition of the peculiar character of the symptoms and in the way they are grouped. Certain toxins give rise to reactions peculiar to them, and we may recognise the diseases they represent by the grouping of the symptoms. These reactions are shown not only by the peculiar association of phenomena but also by specific effects upon individual organs. The recent observations

of Marris and R. M. Wilson, for instance, demonstrate that certain microbes produce toxins that have a peculiar effect upon the heart. By such means there is every reason to expect that we will recognise that groups of symptoms are indications of and peculiar to certain diseased states, although at present our outlook is confused by an inability to distinguish these groups. It will thus be seen how incumbent it is to note carefully each individual symptom, to watch the development of symptoms by keeping in touch with the patients, and applying the principles which are the basis of any scheme for the investigation of disease.

33. Mechanism of an Ordinary Stimulation.—Before discussing the nature of these reflex symptoms it is necessary to appreciate the mechanism by which many symptoms are produced. When a common sensation arises in any part of the body, no matter how it is produced, it is always accompanied by a sense of locality. This sense of locality may be precise and definite, or it may be vague and diffuse, but it has a reference to some particular part of the body. Fig. 1 represents diagrammatically the simplest form of sensation with its attendant localization. It represents a portion of skin (A) which is stimulated and from which a sensation passes into the central nervous system and reaches the sensorium (S), where the sensation is not only perceived, but the part of the body recognised to which the stimulated nerves are distributed.

34. Mechanism of the Radiation of Sensation.—The place in which the sensation is felt is not necessarily the place which received the stimulus. In most

instances a local stimulus applied to the external body wall gives rise to a sensation whose localization by the sensorium corresponds to the part stimulated. It often happens that the area in which the sensation is felt is greater than the part stimulated, and it is then difficult to explain the radiation. An experience related by Professor Sherrington supplies a

Fig. 1.

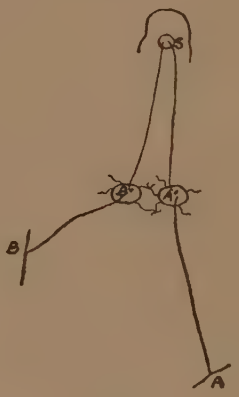

Fig. 2.

Fig. 1.

A stimulus applied to the skin, A, is not only recognised by the sensorium, S, but is referred to a definite area, A.

Fig. 2.

Illustrates the radiation of sensation. A stimulus applied at A is felt not only at A, but in a part of the skin, B, at some distance. This is represented as taking place in some part of the central nervous system where the cells A′ and B′ lie in close proximity.

fitting explanation. The application of a mustard plaster to his chest over the region of the upper part of the sternum gave rise to an unpleasant sensation on the inner side of each arm just above the internal condyles.

It is known that the nerves supplying the skin of the upper part of the chest and the skin on the

inner side of the elbow arise from cells situated close together in the spinal cord, and leave the cord by the second thoracic nerve—one branch of this nerve going to the chest and the other to the arm.

The manner in which the radiation of the sensation takes place is shown diagrammatically in Fig. 2. The stimulus conveyed from A enters the cell A′ in connexion with the nerve fibre, and not only gives rise to a sensation referred to A, the part stimulated, but affects the cell B′ in its immediate neighbourhood. The sensorium recognises the extended stimulation, and refers the resulting sensation to that portion of the skin, B, supplied by the nerve B′. There are many other instances of this kind of referred sensation—for example, the well known instance of the knee pain in hip-joint disease.

From these facts another principle can be deduced—namely, that if any part of the nervous system which conveys the sensation of pain from the skin to the sensorium be stimulated, the resultant sensation is referred not to the part stimulated but to the distribution of the nerve at its periphery. Thus, when the cell B′ was stimulated, the brain became conscious of the stimulation, but the sensation was felt in the skin at B.

35. Mechanism of a Motor Reflex.—A stimulus applied to the sole of the foot may give rise to a sensation of touch, or tickling, or pain, and at the same time may produce a contraction of certain muscles. It is not necessary to infer that it requires a special peripheral end-organ and a separate nerve fibre to receive and convey the stimulus to the sensorium, and another to convey

the stimulus to the motor centre in the spinal cord. A simple diagram (Fig. 3) shows how this comes about. The stimulus applied to the skin; A, passes into the cell A′, and from this cell one stimulus proceeds to the sensorium, and another to the motor cell C′, causing a contraction of the muscle, C.

Fig. 3.

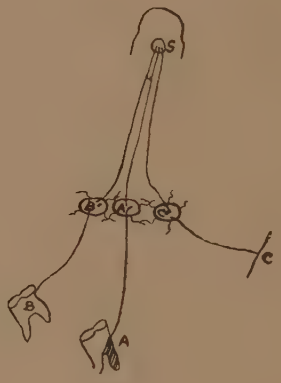

Fig. 4.

Fig. 3.

Illustrates the mechanism of a motor reflex. The stimulus to the skin A produces not only a sensation and its localization, but the stimulus passing through A′ affects the cell C′ and produces a contraction of the muscle C.

Fig. 4.

Illustrates the radiation of pain set up by disease. The diseased tooth A causes pain not only in the neighbouring tooth, B, but also in the skin of the cheek, C.

This reflex stimulation may affect many other centres, some of them easily recognisable, others so elusive that their presence can only be inferred. Later on, when dealing with the reaction produced by visceral disease, it will be shown that a stimulus arising at the periphery may provoke a variety of demonstrable reactions differing widely in character.

36.—Mechanism of Radiation in Disease.—These simple illustrations give a clue to the manner in which symptoms are produced by disease reacting on the central nervous system. This is shown in the simplest way when a demonstrable disease gives rise to symptoms that are easily recognised. Most of us know from personal experience what toothache is, and we have often the opportunity of studying its symptomatology on our patients, if not on ourselves. It frequently happens that the pain set up by a diseased tooth is not limited to the offending tooth, but is felt along the jaw, in the other teeth, and sometimes in the cheek. Indeed, the sound teeth may be so painful, on pressure being applied to them, that the dentist may pull a sound tooth in place of the diseased one. Pain may not only be felt in the cheek, the skin may be so hypersensitive that on brushing the hair pain is produced in place of the normal sensation of touch.

It is to be noted that the spreading of the pain and tenderness in such an instance is not due to the extension of any morbid condition at the periphery—inflammation, for instance—to the neighbouring teeth, for there is no sign of anything the matter with those teeth, while the skin of the cheek is demonstrably free from any diseased condition. Moreover, the discovery and removal of the diseased tooth is followed by the complete disappearance of all pain and tenderness from the other teeth and from the skin of the cheek.

Seeing that these phenomena are produced by one diseased tooth, and seeing that the pain and tenderness of the sound teeth and of the skin of the

cheek is not due to any connection with the offending tooth at the periphery, we are driven to look elsewhere for some connection between these widely separated parts. As there is no communication between nerves except at the cells in the central nervous system from which they arise, we seek for a relation between the nerves of these teeth and the skin of the cheek in the central nervous system. In the case of the diseased tooth the pain was felt not only in the diseased tooth or its immediate neighbourhood, but also in other teeth and in the skin of the cheek, and this radiation is explained by a reference to the diagram Fig. 4, where it is shown that a stimulus arising from the diseased tooth A sends a stimulus into the central nervous system affecting the cell A′ belonging to the nerve of the diseased tooth, so that the sensorium refers the resultant pain to the diseased tooth; but the stimulus also spreads from the cell A′ to the cells B′ and C′, and the resultant pain is referred by the sensation to the healthy tooth B and the healthy skin of the cheek C.

CHAPTER VII.

PAIN.

37. *Definition of Pain.*

38. *Constitution of the Nervous System.*

39. *Difference in the Functions of the two Nervous Systems.*

37. Definition of Pain.—The due recognition of the factors concerned in the production of pain is of the first importance in the study of disease. Not only is pain the most important of complaints, but it is the most instructive diagnostic sign, for the study of its mechanism gives often the key to the best means for attaining relief. The term "pain" used here is easy to understand though difficult to define. It is beside my purpose to enter into abstruse metaphysical considerations regarding the consciousness of pain and its mental affinities. Nor do I include other disagreeable sensations, which are sometimes spoken of as pain, as when a brilliant light or a piercing noise unpleasantly affects the sense of sight or hearing. The term is limited to that very definite form of disagreeable sensation which everyone has experienced, and we all recognise.

The meaning attached to the term pain in this book may be summarised shortly as follows:—

Pain is a disagreeable sensation due to stimulation of some portion of the cerebro-spinal nervous system and referred to the peripheral distribution of cerebro-spinal sensory nerves in the external body wall.

38. Constitution of the Nervous System.—The nervous system consists of two great divisions, which are distinctly separated in their functions, viz., the cerebro-spinal and the sympathetic or autonomic. The former of these divisions consists of the brain and spinal cord, and the peripheral nerves which are distributed to the external body wall and subserve the functions of sensation and muscular contraction. Incorporated within the cerebro-spinal system is the other division, the sympathetic or autonomic nervous system, which includes the origin of such nerves as the vagus and the sympathetic. The position and distribution of the efferent fibres of the autonomic system is shown in Langley's diagram (Fig. 5, page 59). It will be seen that this system presides over the functions peculiar to the different organs. While much experimental work has been done to establish the distribution and functions of the nerves that pass from the centres to the periphery (efferent nerves), little has been done to examine the nerves that pass from the viscera to the central nervous system (afferent nerves). The reason for this is that the nerves passing from the organs to the nerve centres afford little direct evidence of their function, and it has not yet been understood in what way these afferent nerves react to stimulation.

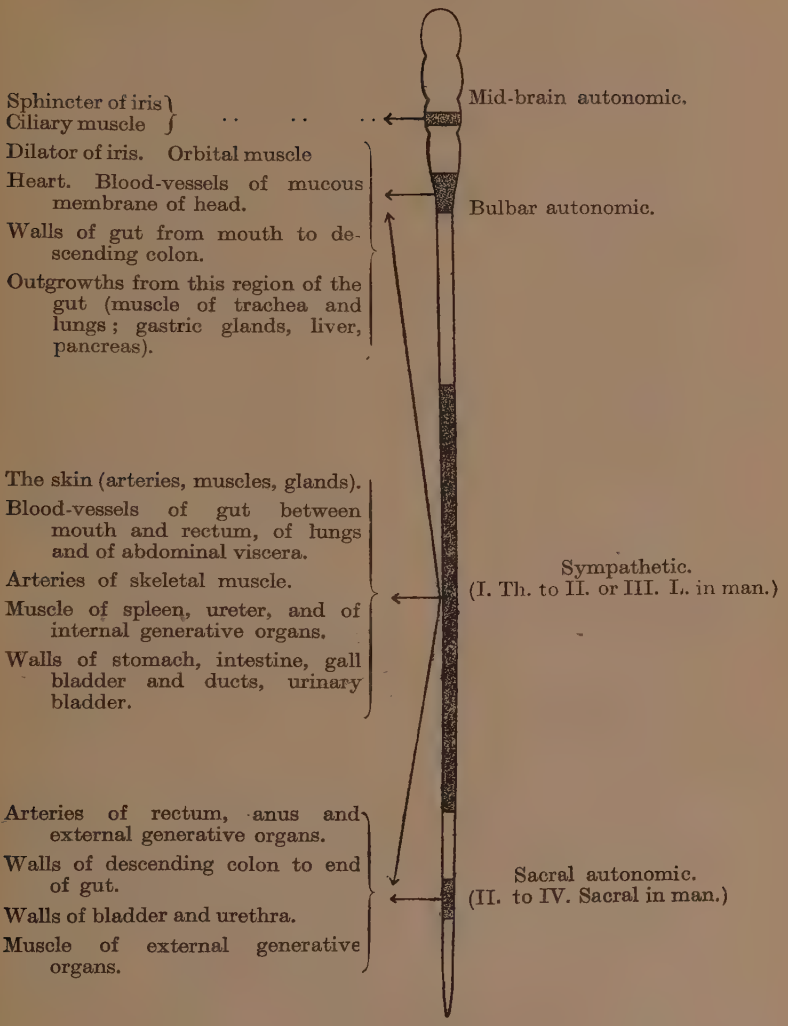
Sphincter of iris
Ciliary muscle
Dilator of iris. Orbital muscle
Heart. Blood-vessels of mucous membrane of head.
Walls of gut from mouth to descending colon.
Outgrowths from this region of the gut (muscle of trachea and lungs; gastric glands, liver, pancreas).
Mid-brain autonomic.
Bulbar autonomic.
The skin (arteries, muscles, glands).
Blood-vessels of gut between mouth and rectum, of lungs and of abdominal viscera.
Arteries of skeletal muscle.
Muscle of spleen, ureter, and of internal generative organs.
Walls of stomach, intestine, gall bladder and ducts, urinary bladder.
Sympathetic.
(I. Th. to II. or III. L. in man.)
Arteries of rectum, anus and external generative organs.
Walls of descending colon to end of gut.
Walls of bladder and urethra.
Muscle of external generative organs.
Sacral autonomic.
(II. to IV. Sacral in man.)

FIG. 5.

Diagram to show the general origin and distribution of efferent autonomic fibres. By "muscle" is, of course, meant unstriated muscle only. By the "walls" of a structure are meant all the unstriated muscle in it. The innervation in some cases is still a matter of controversy (gastric glands, liver, and pancreas; vessels of lungs; small arteries of skeletal muscles, and arteries of the central nervous system). (LANGLEY.)

39. Difference in the Functions of the two Nervous Systems.—In the scheme put forth here, pain and other sensations are regarded as functions peculiar to the cerebro-spinal system, and that for the production of visceral pain it is suggested that under certain circumstances these afferent nerves of the autonomic system convey a stimulus to the cerebro-spinal nerves, so that such phenomena as pain, hyperalgesia and muscular contraction in the external body wall are the evidences of stimulation of the cerebro-spinal nerve centres by the afferent autonomic nerves.

CHAPTER VIII.

THE SENSITIVENESS OF THE TISSUES.

40. *The Tissues Sensitive and Not Sensitive to Mechanical Stimulus.*

41. *Sensitive Tissues of the External Body Wall.*

42. *Insensitiveness of the Viscera to Mechanical Stimulation.*

43. *Methods for Testing the Sensibility of Organs.*

44. *Testicular Pain.*

45. *Artificial Production of Visceral Pain.*

40. The Tissues Sensitive and Not Sensitive to Mechanical Stimulus.—A step preliminary and necessary to understanding the nature of the symptoms of disease is a knowledge of the sensibility of the different tissues of the body. A great field for investigation still lies unexplored, and so long as it is neglected the understanding of the symptoms of disease will be defective. In the attempt to investigate this field I have only been able to make a slight advance, but such as it is, it has thrown new and unexpected light on a great many problems connected with the symptomatology of disease.

If we inquire into the response of the different tissues to such mechanical stimuli as produce the common sensations of pain, touch, heat, pressure, etc., we discover that these sensations are limited to certain portions and organs of the body, and that there are large portions of the body totally insensitive to all such stimuli. Looking at the matter broadly, we find that while all the structures which make up the external body wall are more or less sensitive to such stimuli, the viscera and the serous lining of cavities are, with one exception, irresponsive to this kind of stimulation.

Thus, if we apply a mechanical stimulus to the skin we produce a sensation peculiar to the nature of the stimulus, as, for example, touch, pain, heat, or cold. If we apply the same stimuli to the viscera or to the serous surfaces or internal structures of organs we get no response, or rarely a response of a different nature. Thus, if we prick the skin near such an orifice of the body as the anus, we can produce pain, but as soon as the mucous membrane is reached the pricking no longer produces pain. In testing other orifices of the body—for example, the mouth—a modified sensation is felt, but at a certain depth of the gullet all sensation ceases.

If we inquire into the reason for this difference in the response to stimulation we will find it in the nerve supply of these different tissues. Thus the tissues which give rise to sensation in response to mechanical stimuli are supplied by the cerebro-spinal nerves, while the tissues which do not respond receive no nerves from the cerebro-spinal nervous system, but are supplied only by the sympathetic nervous

system, or what is sometimes spoken of as the involuntary nervous system.

41. Sensitive Tissues of the External Body Wall.—If we take the abdominal wall we find three great layers endowed with exquisite sensibility to pain. The first of these, the skin, I need not dwell upon, save to point out how its sensibility frequently becomes increased in visceral disease, and how this increased sensitiveness is united to an exalted muscular reflex. The second of these sensitive layers is the voluntary muscular system, best observed in the flat muscles of the abdomen. It is the sensitiveness of this muscular layer which is most commonly exalted in visceral disease, its sensibility being very readily increased. Muscular hyperalgesia is such a striking phenomenon, is so frequently present and plays such an important part in the protective mechanism, that it is astonishing to find it almost universally overlooked. One can read elaborate treatises devoted to special organs, in which this symptom is the most striking and the most instructive feature, but its presence is nevertheless overlooked or misinterpreted. In an ordinary case of stomach ulcer, appendicitis, gall-stone, renal colic, or enlarged liver, if one notes the tenderness of the abdominal wall, and observes how this deep tenderness extends far beyond the site of the organ affected, one can appreciate the nature and significance of this sensitive layer. With a little care one will be able to distinguish this muscular hyperalgesia from cutaneous hyperalgesia and from hyperalgesia of the deeper tissues. The third sensitive layer is one of which anatomists and physiologists were quite ignorant till

recently, though it has long been suspected from clinical observations. It is the layer of loose connective tissue lying immediately outside the peritoneum. I suspected its presence for a long time as I could frequently get exquisite tenderness in pushing my fingers between the recti muscles, for instance in cases of gastric ulcer, the stomach not being affected by the pressure. Its existence can be shown in an operation for the radical cure of hernia under cocaine anæsthesia. The skin and muscles can be cut through, and the patient experiences no pain. When the loose connective tissue outside the peritoneum is gently torn through the patient may experience most exquisite pain. After the peritoneum is exposed it can be incised, its visceral layer scratched and afterwards stitched, and the patient feels no pain. I have verified this observation on several occasions. Ramström has made a careful histological examination of the abdominal wall of man and other mammals, and showed that this region is richly endowed with nerves and nerve endings, the nerves being derived from those which supply the muscles of the abdominal wall. This observation may probably afford a clue to the confused statements that exist in regard to the sensitiveness of the peritoneum. I can only say this, that I have on numerous occasions in the course of operations scratched and cut the serous surface of the peritoneum on conscious subjects without any analgesic, local or general, and have never known the slightest sensation elicited. One can understand, however, that the inflamed peritoneum and adhesions might readily affect this remarkable nervous layer. Peritonitis, however, so readily

produces muscular hpyeralgesia and tonic muscular contractions (viscero-motor reflex), that the pain and tenderness are demonstrably, in the majority of cases, of spinal origin.

42. Insensitiveness of the Viscera to Mechanical Stimulation.—The insensitiveness of the viscera to mechanical stimulation has been repeatedly demonstrated. Haller described a series of experiments where he exposed in animals certain viscera by operation, leaving an opening by which they could be reached. Afterwards, while the animal was feeding, he introduced through the opening instruments that cut and burnt the organ, and the animal paid no attention to what he was doing. I have myself repeatedly tested in the conscious human subject the various organs by cutting, stitching, and tearing, and no sensation was elicited.

The insensitiveness of the viscera and its full significance has not been grasped. Indeed, the belief is common that the viscera are endowed with common sensations, and what is supposed to be evidence is easily obtained.

43. Methods for Testing the Sensibility of Organs. The sensitiveness of tissues to stimulation is one of those apparently simple problems which it is assumed anyone can solve. As a matter of fact, no one has been sufficiently trained to undertake such an investigation. A large amount of work has been done on the subject by physiologists, neurologists, psychologists, physicians, and surgeons, yet, notwithstanding their opportunities, they have failed to investigate the matter in a manner calculated to reveal the true facts, and so the conclusions which are

current to-day are based on imperfect observations, and in consequence are misleading. I comment on this fact as one of many instances where the progress of medicine is hampered by a lack of understanding of the manner in which investigation should be conducted. I do not at present wish to enter fully into the matter, but mention a few points to show the imperfect methods which have been used.

The first point which arises is, that no conclusion should be drawn as to the sensitiveness of an organ which has been stimulated through a structure itself sensitive. Nearly all conclusions have been drawn from observations made by pressing on the organs through the sensitive abdominal wall. Many observers state that they have demonstrated the sensitiveness of an organ by first observing its position by various methods, such as the *x* rays, and later by pressing over it and eliciting pain. The error here lies in the failure of the observer to take the precaution of excluding the sensitive external body wall. If, for instance, when such sensitiveness has been detected, an attempt is made to delimit the area that is sensitive, it will be found that the size and shape of the area painful on pressure bears no relation to the size and shape of the organ supposed to be tender. I discussed this matter with a very skilled physician. He demurred to my statement that there was no evidence of the sensitiveness of organs. He declared that he had a patient with a large liver which he could demonstrate to me was extremely tender. I asked to see this patient and was shown him. The enlarged liver was easily palpated, the lower margin being sharp and well

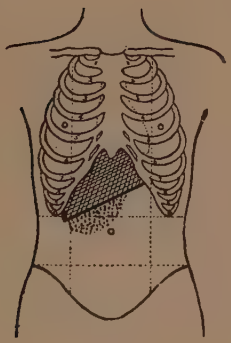

FIG. 6.

The shaded area represents the liver, the dotted area the extension of hyperalgesia beyond the liver margin, showing the pain elicited by pressure over the liver was due to an increased sensitiveness of the tissues of the external body wall.

defined. On gently pressing over the liver the patient winced from the pain. I asked the physician to map out the region that was so manifestly tender, and to his surprise he found the tenderness extended 3 in. lower than the margin of the liver (Fig. 6).

It is well known that pain does occur in disease of the viscera, and in animals distress has been provoked by certain experiments. But here the experimenter never realised that the evidences of suffering, even if these were due to pain, gave no information as to the locality of the pain—a fact absolutely essential to the understanding of the mechanism by which visceral pain is produced. The same neglect of this essential matter is found in the observations of surgeons and others who have studied pain in the exposed organs of the human subject.

With the recognition of these sensitive structures—frequently rendered exquisitely sensitive to painful stimuli in visceral disease—it will be understood how impossible it is to judge of the sensitiveness of the viscera from external exploration. When, therefore, we find the surgeon or physician demonstrating the sensitiveness of any viscus, it will be realised that he is in reality stimulating, in his examination, those extremely sensitive structures of the external abdominal wall, and referring the pain he elicits to an organ that is totally insensitive to any such stimulation.

44. Testicular Pain.—On the other hand, one cannot always be sure of the source of pain, as when pressure is applied over a movable kidney or readily palpated abdominal tumour. That pain arises on pressure on a viscus is undoubted, but the pain does not seem to arise from the direct stimulation but by reflex stimulation of a sensory cerebro-spinal nerve. This can be demonstrated in the case of the testicle. In ordinary cases when the cord is

short the pains felt on applying pressure to the testicle are not readily differentiated. If, however, an individual with a long cord, where the testicle hangs down a long way from the groin, be examined, the pains resulting from pressure on the testicle can be separately recognised. In such an instance a pain is felt at once readily localised over the point of pressure. A few seconds later another pain is felt gradually increasing in intensity, and gradually passing away and referred to the groin. Accompanying the pain there is sometimes a sensation of faintness, very slight with light pressure, but evidently of the same nature as the intense depression following on a blow on the testicle. This depression and pain are similar to those which are evoked by pressure on the kidney and ovary. Concerning the first of these pains when it is felt at once and referred to the place of stimulation, a curious question arises bearing on the sensibility of serous membranes. As I have already pointed out, I have scratched the serous surfaces of both visceral and parietal peritoneum and pleura, and elicited no sensation of pain, but exquisite pain may be elicited by scratching the tunica vaginalis. In certain cases in tapping a hydrocele, if the testicle be gently held with one hand and the visceral layer of the tunica vaginalis lightly scratched with the canula, the patient at once experiences pain and refers the pain unerringly to the region scratched. However lightly the stimulus is made no sensation is experienced beyond that of pain, resembling in this respect the sensibility of the cornea. As demonstrating the difference between the sensibility of the tunica

vaginalis and the peritoneum, I cite the following experience. A patient consulted me with his scrotum greatly enlarged and full of fluid, which I took to be a hydrocele. I tapped him and tested the sensibility of the testicle. I found the patient did not feel pain when I scratched what I took to be his tunica vaginalis. I scratched rather roughly, yet no painful sensation was experienced. Finding I could not reduce the whole of the swelling I concluded that the case was not one of hydrocele, and on operating I found the case was one of omental hernia with the sac distended by peritoneal fluid. What I had been scratching was the peritoneum.

As the tunica vaginalis and the peritoneum have the same origin it appeared strange that there should be this difference in sensation, until on inquiry I found that a cerebro-spinal nerve is distributed to the tunica vaginalis, viz., a twig of the genital branch of the genito-crural nerve. The tunica vaginalis is the only sensitive serous membrane covering an organ that I have detected, and it is the only one to which a branch of a cerebro-spinal nerve has been traced.

In certain cases the tunica vaginalis becomes hyperalgesic (*see* page 183). Professor Waterston tells me that the visceral layer of the tunica vaginalis is not of the same origin as the parietal, but is looked on as a persistence of the germinal epithelium. This may have some bearing on the sensibility of the testicle, and my suggestion as to the nature of the testicular sensitiveness is therefore provisional.

45. Artificial Production of Visceral Pain.—It is a curious fact that although the belief is so universally held that the viscera are endowed with "sensory" nerves, and that physiologists refer to afferent sympathetic nerves as "sensory" in function, not a single authentic observation has been rendered to show that the viscera have a direct sensibility of their own, *i.e.*, a sensibility derived from the possession of nerves which when stimulated produce a sensation. Of course, a great deal depends on what is considered evidence, many people being perfectly satisfied if they elicit pain by pressing over an organ. Physiologists have interpreted certain movements as an expression of pain after stimulating afferent sympathetic nerves. But this does not prove that pain was evoked nor does it prove that the pain was a direct pain, nor does it show in what situation the pain was felt, for the location of the pain is the key to the problem. It is therefore necessary in investigating this matter to be sure of the tissue stimulated, and the region in which the resultant pain is felt. It is because of the absence of the specification of the locus of the pain that many otherwise important observations are rendered of little value in respect to this investigation.

That pain can be produced by visceral stimulation is easily demonstrated if one employs an adequate stimulus. It is now many years since I pointed out that the most violent pains of which we are conscious are associated with hollow muscular organs, and that by producing violent contraction of a hollow viscus pain can be elicited. The easiest way to do this is to give a distending enema of warm

water, and to retain the enema until painful peristalsis results. That the pain is really due to the contraction of the muscle wall of the bowel is evident from the fact that with the relaxation of the sphincter during the pain the contents of the bowel are expelled with considerable force, and the pain at the same time subsides. Here it is evident that a considerable portion of the descending colon and rectum must have contracted, but the pain is not felt along the position occupied by these structures, but, in the majority of people, it is referred across the middle line immediately above the pubis.

The following observation demonstrates an exactly similar series of facts :—

I had occasion to resect a small portion of the small intestine in a conscious subject, for umbilical fistula, whose abdominal cavity I laid open. He refused to take an anæsthetic, and no analgesic, local or general, was administered. There were numerous peritoneal adhesions, and while I cut and tore these the patient was unconscious of any sensation. I cut and stitched the serous surfaces of parietal and visceral peritoneum, I tore adhesions from the liver, I cut and sutured the bowel and mesentery, and no sensation was felt. After preparing the upper part of the bowel it was wrapped in a warm cloth and laid on one side. During the subsequent steps the patient frequently moaned. I asked him if he felt pain, and he replied that he did. I asked him where he felt the pain, and he indicated with his hand that it was across the middle line at the level of the umbilicus. I at first felt that it might be due to the part that I was manipulating, but the pain was

intermittent. Chancing to look at the prepared upper part of the bowel that lay on the left side of the abdomen, I observed that every few minutes a peristaltic wave passed over the lower portion of it, and when this occurred the patient moaned in pain. I made certain that the pain was connected with the peristaltic wave, and I produced the peristalsis several times by lightly pinching the bowel. I also made sure the patient had no doubt as to the place in which it was felt, with the result that here before my eyes was the cause of the pain which the patient felt, and yet the patient referred the site of the pain with precision to an area ten inches or twelve inches away from the contracting bowel.

CHAPTER IX.

VISCERAL REFLEXES.

46. *The Mechanism of Visceral Pain (the Viscero-sensory Reflex).*

47. *The Mechanism of the Viscero-motor Reflex.*

48. *Multiple Reflexes from Visceral Stimulation.*

46. The Mechanism of Visceral Pain (the Viscero-sensory Reflex).—The remarkable difference between the sensitiveness of the external body wall and the viscera in response to mechanical stimulation brings out clearly the difference in function of the two divisions of the nervous system—a difference which it is necessary clearly to understand if the symptoms of disease are to be fully comprehended. It shows that when pain is evoked from the organs or tissues which are not supplied by the sensory nerves of the cerebro-spinal system some other mechanism must take part in its production.

The nature of this mechanism is revealed by the study of the symptoms produced in certain forms of visceral disease. If we take the symptoms that are present in certain simple diseases—for example, a gastric ulcer, appendicitis, or renal colic—the mechanism by which a number of symptoms are produced will become clear. In many cases of gastric ulcer there is pain, limited to a small area,

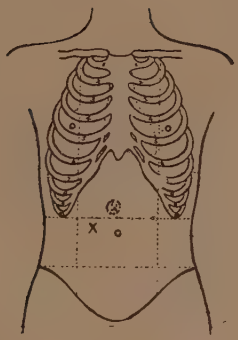

Fig. 7.

The shaded area in the centre shows the position of pain and hyperalgesia in a case of ulcer of the pylorus situated at x.

in the epigastric region. This pain has a different location from the ulcer. Thus the pain may be situated in the middle line, as in Fig. 7, where the shaded area indicates the site of pain, while the ulcer revealed at the *post-mortem* examination is situated at the pylorus, which was found at x in Fig. 7. Moreover, if a patient with this pain breathes deeply, the stomach, with the ulcer, shifts its position, but the site of pain remains fixed. With these facts before us, the mechanism of pain in visceral disease becomes clear. When the disordered sensations of toothache were considered

it was seen that the only reasonable explanation was that from the offending tooth a stimulus had been sent into the central nervous system (page 54). The effects of this stimulus were not limited to the cells of the nerve supplying the tooth, but spread to the cells of sensory nerves in the immediate neighbourhood, with the result that there was pain and

Fig. 8.

Fig. 9.

Fig. 8.

The normal movements of a viscus, x, pass into the central nervous system, x', but produce no sensation.

Fig. 9.

Shows the mechanism of a viscero-sensory reflex. A stimulus arising in a diseased organ, x (as in gastric ulcer), passes into the central nervous system, x', and if the stimulus be of a particular quality or strength it will affect a neighbouring sensory cell, B', which is recognised as pain and referred to the peripheral distribution of the nerve at B.

hyperalgesia in neighbouring teeth and in the skin of the cheek.

From the stomach a stimulus is conveyed by the sympathetic nerves into the central nervous system. But as these nerves are not "sensory" nerves in the sense that they are directly connected with any perceptor in the brain, no sensation is felt (Fig. 8).

In like manner, so long as the impulses conveyed from the ulcer do not spread no pain is felt. When, however, the stimulus is of such a nature that it spreads to other cells, then we get a reaction peculiar to the cells stimulated. In this case the stimulus reaching the nearest sensory cells of the cerebro-spinal system irritates them, and the pain which results is referred to the peripheral distribution of the nerve stimulated—that is, the nerves supplying the area of skin as already described in paragraph 34 on referred pain. Fig. 9 illustrates the mechanism by which pain is produced in visceral disease, showing how an organ itself insensitive and supplied only by sympathetic nerves can produce pain by reacting upon the cells of the cerebro-spinal sensory system. The stimulus arising in the organ x passes to the central nervous system, where its cell, x′, has no direct connection with the sensorium, s, but when an adequate stimulus arises it affects the neighbouring cell, b′, which, being a pain nerve, gives rise to the sensation of pain which is localised at its peripheral distribution.

47. The Mechanism of the Viscero-motor Reflex. Before dealing with other phenomena produced by visceral disease it is necessary to consider the mechanism of the reflex which produces contraction of voluntary muscles as a result of a stimulation from the viscera. When we carefully palpate the abdominal wall in patients with disease of some abdominal organ, we will frequently find certain portions of the body wall hard and resistant. This manifestly is due to a contraction of a portion of one or more of the broad muscles which form the

abdominal wall. It is a reflex contraction produced by a stimulus arising in the diseased viscus and sometimes referred to as "protective rigidity" of the muscles, as its purpose is obviously to protect the diseased organ. Every doctor is aware of this hardness in the epigastrium in gastric ulcer, due to rigidity of the upper portion of the recti muscles. The manner in which it is produced is similar to that operating in the case of the cutaneous reflex contraction and may be diagrammatically represented

FIG. 10.

Shows the mechanism of the viscero-motor reflex. A stimulus arising in a diseased organ, x, passes into the central nervous system, x', and affects a neighbouring cell, c', which causes a contraction of skeletal muscles, c.

as in Fig. 10, where the stimulus from the viscus x, passing to the cell x′ in the central nervous system, excites the motor cell c′, which produces a contraction of the muscle c.

There are different forms of reflex muscular contraction. The cutaneous reflex contraction is accompanied by a sensation; viscero-motor contraction is not necessarily accompanied by a sensation. The cutaneous reflex results is a momentary

contraction of the muscle. The contraction of the muscle which arises from the visceral stimulation is persistent. In this persistent contraction of the muscle we get an insight into several processes of a very instructive kind. Light is thrown on some functions of the sympathetic system at present obscure, and some characteristic features of muscular contraction which have been overlooked are revealed.

From the study of this contraction it can be demonstrated that the tone maintained by the flat

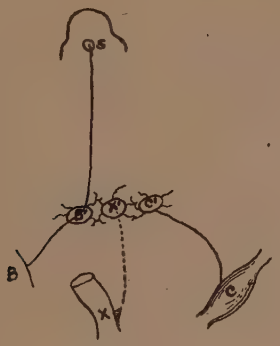

Fig. 11.

Shows the mechanism of a combined viscero-sensory and viscero-motor reflex. (See Figs. 9 and 10.)

muscles of the abdomen is partly dependent on the stimuli reaching the motor cells of the muscles from the viscera. If we carefully watch certain cases of visceral disease, such as gastric ulcer, we will often find a varying degree of muscular rigidity. It may scarcely be possible to distinguish this increased resistance from that of the normal tone and resistance to palpation in unaffected muscles. This resistance often increases until the muscle is felt hard and

board-like, and after a time it may subside and disappear. When the increased resistance is scarcely perceptible, it can be increased by rubbing gently along the muscle. Sometimes in walking the contraction of the muscle may be increased so that the patient walks with a stoop. The varying degrees of contraction are in all likelihood associated with varying degrees of activity of the disease, and I have at times found them of value in the management of such diseases as gastric ulcer. But the point I wish to make here is that this increase in contraction is evidently but an exaggeration of that condition called tone which is normally present in health.

Frequently these muscle contractions are associated with hyperalgesia of the skin overlying them, and the muscles themselves may be hyperalgesic. When this cutaneous hyperalgesia is present the cutaneous reflexes show some interesting variations. If the muscle is not contracted, or only slightly contracted, the reflexes may be much more lively in response to stimulation of the hyperalgesic skin. If the muscles are hard and board-like, the reflexes may seem to be abolished; little or no movement is obtained from stimulating the hyperalgesic skin, for the reason that the muscles are already contracted to their full extent.

It occasionally happens that we find the muscle distinctly contracted, with no cutaneous nor muscular hyperalgesia, as shown in Fig. 9. At other times we may find hyperalgesia of the skin only. Most frequently there is both cutaneous and muscular hyperalgesia along with a contracted muscle, as

shown in Fig. 11, where the stimuli from x affect B′ and C′, producing in the one case pain referred to B and in the other contraction of the muscle C.

48. Multiple Reflexes from Visceral Stimulation. So far, in speaking of reflexes, I have referred to some as occurring singly. As a matter of fact, no stimulus produces only one reflex ; there are always others. Some of these are so slight as not to be recognisable ; others, quite a number of them, can be recognised.

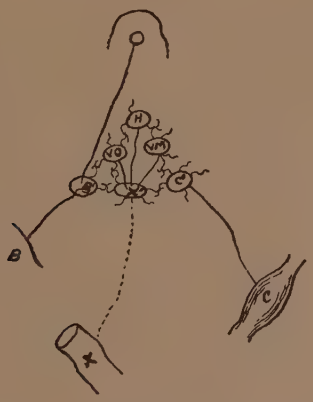

FIG. 12.

Illustrates the mechanism of multiple reflexes produced by visceral stimulation. An adequate stimulus arising in an organ, x, passes to x′ in the central nervous system and affects a series of neighbouring cells, thus giving rise to pain (by stimulating B′), muscle contraction (by stimulating C′), vomiting (by stimulating the centre for vomiting, VO), cardiac depression (by stimulating the vagus, H), pallor and sweating (by stimulating the vasomotor centres, VM).

If, for instance, we consider the symptoms provoked by the peristalsis of a hollow muscular organ the origin of a number of phenomena will be revealed. The presence of a small calculus in the pelvis of the kidney may set up a strong peristalsis of

the ureter, giving rise to an attack of renal colic. With the onset of the attack uneasiness or pain is first felt, and the muscles of the abdomen become hard. In one patient the testicle was pulled up by the contraction of the cremaster muscle. The pain passes from the loins downwards into the testicle. It comes on in wave-like periods of intensity. Other symptoms arise — for example, vomiting, great prostration, with feeble action of the heart—so that partial loss of consciousness may follow. There is also pallor and profuse sweating. All these phenomena are produced by a stimulus reaching the central nervous system and there reacting on a number of special centres, such as the vomiting centres, the centre for regulating the vasomotor nerves, the centre of the vagus (Fig. 12).

When the attack passes off there is left a variety of phenomena, such as an area of cutaneous hyperalgesia with contraction of certain of the muscles of the abdomen. In addition there is usually ushered in a period of great exhaustion or prostration, lasting, it may be, for a number of days. I wish here to clear away one of those beliefs which does so much to darken understanding and hamper investigation. Phenomena, such as exhaustion and vomiting, when they accompany such an attack, are usually attributed to the pain. This is a pure assumption, for the centres which control vomiting and exhaustion are as distinct as the pain centres, and a stimulus which excites pain may, under certain circumstances, also excite those centres. When pain of great severity occurs without vomiting or exhaustion, it simply means that the stimulus

which excited the pain did not affect those other centres. On the other hand, those centres may be stimulated, and vomiting and exhaustion may be produced without pain. Thus, it frequently happens that a sudden movement of the bowels resulting in the evacuation of a large loose motion is accompanied by vomiting and fainting without pain.

Chapter X.

DIMINISHED RESISTANCE TO STIMULATION.

49. *Focal.*

50. *General.*

51. *The Soldier's Heart.*

52. *War Neuroses.*

53. *The Mechanism of Symptoms.*

54. *Practical Importance of Recognising the Mechanism of Symptoms.*

49. Focal.—Another feature of the nervous system which has not received from clinical observers the attention it merits—namely, the lowered resistance to stimulation which is produced by disease and other agencies.

In describing the phenomena of toothache, the well-known facts of tenderness of the neighbouring healthy teeth and of the hyperalgesia of the skin of the cheek were commented on. A similar state of affairs is met with in connection with visceral disease, for we often find in this condition that pressure over certain regions of the abdomen of a degree which in other parts of the body produces only the sensation of touch or pressure, gives rise to pain. In lightly pinching the skin, too, pain is caused over particular areas, whereas no pain is

felt in other areas. Frequently the skin itself is not hyperalgesic, but the deeper structures of the abdominal wall, especially the muscles, are painful on pressure.

In normal circumstances a stimulus has opposed to it a degree of resistance in producing pain. Its entrance into the pain centres is hindered, so that it must be of a certain strength or quality before it can pass. In these hyperalgesic areas which I have described the resistance to stimulation is greatly diminished, so that a stimulus much weaker than that which produces pain in other regions is sufficient to produce pain in these regions; in technical language, the "threshold of stimulation" is lowered. A similar lowering of the threshold is shown by the cutaneous reflexes. Thus when a hyperaesthetic area of skin is stimulated so as to produce a contraction, a slighter stimulus suffices for the act, and the contraction of the muscle produced is greater than in corresponding parts on the opposite side of the abdomen.

But the evidence of the diminished resistance is not limited to sensory and motor regions in the spinal cord. This may affect the whole nervous regulating mechanism of an organ. The phenomenon is best demonstrated in the circulatory system. In certain cases the movements of the heart and the vasomotor mechanism may respond to mild stimulation in an excessive manner—for example, an excessive rate of the heart on mild exertion or an excessive contraction of the blood vessels from some slight stimulus as, for instance, mental effort or exposure to cold. Thus, in a patient

with aortic regurgitation, I have seen the blood pressure rise when the patient was engaged in a quiet conversation, and I have seen this rise followed by a violent attack of pain. Indeed, in certain sufferers from heart disease the nervous mechanism of the organ may become so sensitive to stimulation that this may provoke attacks of palpitation or of pain. This stimulation may consist of factors which do not directly affect the heart—for example, mental excitement, the excitation of the skin of the left chest by pressure of a stethoscope, or a mere movement of the left arm of the patient. Numerous instances of the lowering of the threshold of stimulation will occur. People in whom the fingers become cold, pale, and numb, on exposure to a very moderate degree of cold, have an excessive sensibility of certain vasomotor centres. Some people, again, when worried or fatigued suffer from persistent vomiting.

50. General.—The purpose of these illustrations is to call attention to a factor which has only been dimly perceived, but which is a very important element in the production of a large class of symptoms. This factor is diminished resistance to stimulation. So far instances of it have been confined to diseases of a simple kind—for example, toothache, gastric ulcer, disturbances of the heart and vasomotor system, and of the vomiting centre. It will now be profitable to inquire whether there are not conditions in which the diminished resistance may be of a much greater extent, for if such conditions be found we may find at the same time a clear explanation of the manner in which many symptoms are produced.

We know that when a patient becomes the subject of a microbic infection there is speedily induced a loss of the sense of well-being and the appearance of sensations of discomfort or suffering. The daily routine becomes laborious and difficult; it is accompanied by loss of appetite, and fatigue is easily brought on. Indeed, so readily may exhaustion be produced that, even with a mild infection, collapse of an extreme kind may occur—as, for instance, in the case of a youth training for a race who fell and lost consciousness in running a short distance. Before starting he felt seedy, but thought he could throw the feeling off by the exercise. He was found to have a slight rise of temperature; in a few days he was well and resumed his training, which he completed without mishap. If patients with a mild infection be observed it will often be found that their heart's rate is increased, and that their response to effort is accompanied by an undue acceleration of the heart's rate, while breathlessness and fatigue are more readily induced than in health. These facts are well known to every observing doctor, and their interpretation seems to be that something has occurred which has lowered the resistance to stimulation. As a result the heart is more readily stimulated to rapid action, and a disturbance of the vasomotor mechanism takes place which leads to exhaustion or loss of consciousness.

If an individual, the victim of a mild infection, persists in leading the strenuous life he may have pursued when enjoying vigorous health, other manifestations develop. The heart's exhaustion may proceed apace till breathlessness is readily

produced on moderate exertion. Pain, too, may be experienced, sometimes of such severity that it is diagnosed as angina pectoris, while the skin of the left side of the chest may become extremely hyperalgesic.

The following experiences show what I am trying to demonstrate. A woman fell into ill-health of a vague kind, but developed attacks of pain in the left chest, evidently of cardiac origin, of such severity that several experienced physicians diagnosed the condition as one of angina pectoris of a very grave type. Little relief was obtained, and the case dragged on for months. When I saw her I felt confident that the attacks of pain, though cardiac in origin, were not due to organic disease of the heart, but that she was suffering from some toxic condition, and a search was made for some source of infection. The only suspicious circumstance was an obscure swelling in the pelvis, whose nature an expert gynecologist could not determine. After a few weeks an abscess burst into the bladder, and after the discharge of pus the attacks of "angina" gradually disappeared, and she made a good recovery.

A man fell into poor health. He became depressed in spirits; his brain was readily exhausted after reading a short time; he was short of breath on exertion, and easily tired. He flushed readily, and his heart beat rapidly on the slightest exertion. Nothing amiss could be detected on physical examination till, after some months, a certain degree of discomfort directed attention to his mouth, and he was found to have an abscess in his antrum. The evacuation of the pus was followed by a speedy recovery.

It is manifest, from a history of such cases, that the primary cause of trouble was an infection which poisoned certain structures of the body, in particular the nervous system and regulating mechanism of the heart and blood vessels, and rendered those parts abnormally sensitive to stimulation, so that bodily or mental effort, which in health could be undertaken without distress, now induced the signs of exhaustion peculiar to each organ.

What is true of the circulatory system is true also of every other system. When we meet with symptoms of the disturbance of one organ a systematic inquiry will often lead to the detection of evidence of functional disturbance in other organs.

This matter can be illustrated by a consideration of experiences that have lately been familiar to most doctors in the so-called "soldier's heart" and the neuroses of war.

51. The Soldier's Heart.—For a long time before the war I had puzzled over the description of the condition called the "irritable heart of soldiers." Many years ago I had seen men in good health who had been invalided out of the army because of this affection, and I could find nothing the matter with their hearts. When the war broke out I seized the opportunity to find out the nature of this condition. At the suggestion of the Medical Research Committee a systematic investigation was undertaken by Dr. R. M. Wilson and myself, and we produced a preliminary report on the subject. The work was ultimately carried on at hospitals set apart for the purpose; but I continued my own investigations, and briefly the following are the conclusions to

which I came: The condition which goes now under a variety of names—as the soldier's heart, the irritable heart of soldiers, disordered action of the heart, effort syndrome, and neuro-muscular asthenia—is not peculiar to soldiers, but is of frequent occurrence in civil life. The ill-health or incapacity which is present is not limited or only due to the cardiac condition, for other organs are also affected, so that the cardiac manifestations form but a part of the picture of ill-health. The main symptoms of which the soldiers complained were shortness of breath or exhaustion or palpitation easily produced on moderate effort. In some cases pain in the chest was felt, sometimes of great severity, coming on in response to effort or when at rest. An examination revealed in some an increased rate of the heart, and in many an excessive increase in response to effort. Occasionally there was a slight enlargement of the heart.

In the limitation of the response to effort (shown by breathlessness easily produced) and in the increased rate of the heart we get evidences of increased susceptibility to stimulation on the part of the organ.

A heart in this condition of undue excitability, compelled to do the same amount of work as it did when the health was good, will become sooner or later exhausted, and so we will find a series of symptoms arise which are the outcome of exhaustion.

While the over-excitability of the heart is brought about mainly by a disturbance affecting its nervous mechanism, in all probability the same injurious influence affects the myocardium itself, so that the efficiency of the heart may be impaired.

52. War Neuroses.—The foregoing are, in brief, the chief manifestations of the irritable heart of soldiers. But if the patient be more carefully scrutinised other symptoms will be found. His face is often lined and drawn; he is often nervous in manner, and occasionally he shows fine tremors in his hands and fingers. Inquiry reveals a varying degree of mental disturbance, apathy, disinclination for exertion, mental depression, and irritability of temper. The memory is not retentive, and on mental effort—for example, reading—fatigue is readily induced. In many cases other phenomena are detected, but these are sufficient to show that in nearly all these cases there is a mental side to the ill-health as well as a cardiac.

If one were to concentrate the attention on the nervous phenomena in a great many of these cases, the conclusion arrived at would be that the patient suffered from a neurosis. Indeed, this is what is constantly happening, for certain doctors would unhesitatingly class some soldier patients as suffering from neurasthenia, or some other form of war neurosis, while others would class the same patients as suffering from the irritable heart of soldiers.

If the inquiry be carried further definite symptoms of derangement of other organs can be obtained. Thus a rapid respiratory rate, not due to any lung or heart affection, may probably, as Haldane pointed out, be due to an excessive irritability of the respiratory reflex. Digestive disturbances are present in the great majority. Did we possess the knowledge we might almost certainly discover signs pointing to the deranged function

of every organ of the body. Indeed, some physicians have detected signs of hyperthyroidism in so many of these cases that they attribute most of the circulatory disturbances to this condition.

53. The Mechanism of Symptoms. — The inference drawn from such experiences was that a condition of diminished resistance to stimulation had been induced, and the attempt to lead the life and do the work of healthy vigorous men had proved unavailing. Health had given way from exhaustion. The manifestations of this exhaustion were exhibited by the different organs that had been submitted to the strain; in one case the heart and circulatory system were most affected, in another the nervous system. Thus we get the variety of phenomena which these soldiers exhibit.

This way of looking at the matter illustrates a method of investigation that has not been so fully appreciated or utilised in medical research as it deserves. It shows the importance of applying the "law of associated phenomena" in all medical examinations. This law is based upon the fact that in ill-health there are a great variety of phenomena. It has been the habit to a large extent to give consideration to the more prominent signs and to label the disease by the names of such dominant signs. We constantly met soldiers invalided and pensioned on account of so-called aortic or mitral disease, because a systolic murmur had been detected, yet in the vast majority of these cases there was absolutely nothing the matter with the aortic or mitral valves. If the principles underlying the classification of symptoms and the law of associated

phenomena had been understood such mistakes would not have arisen.

Physicians who have been engaged in war work are now publishing their experiences, and we find in the medical journals that the old method of docketing the soldiers' complaints according to the organ supposed to be affected is pursued. Thus we have sick men described as cases of irritable heart, of neurasthenia, and of hysteria; that is to say, the complaints are attributed to the organ whose symptoms are most prominent to the observer.

54. Practical Importance of Recognising the Mechanism of Symptoms.—It may seem that this aspect of the matter is already recognised, and that the presentation of it in this way is unnecessary. But it frequently happens that what is supposed to be well known and commonplace is in reality so imperfectly known that its true significance has been entirely missed. In the cases to which I am referring it will be seen that the procedure usually employed in medicine, of describing diseases as limited to one organ or system, is misleading.

Recognition of this general lowering of resistance to stimulation enables one to perceive that the manifestations of the different organs are but an expression of the irritability of their nervous mechanism, and compels an inquiry into the condition which has induced it. In many cases such an inquiry will result in the discovery of some focal disease or in the detection of some infection—for example, malaria or dysentery, or tubercle.

Another important result of this recognition is that we are no longer so likely to be misled in the

estimation of the significance of some abnormal sign. A large number of these cases of "soldier's" heart are labelled "valvular disease of the heart" because there is a systolic murmur present, and the limited response to effort, breathlessness on exertion, or increased rate of the heart, is taken to be evidence of an organ impaired by mitral or aortic disease. I know that large numbers of cases have been invalided out of the army and granted pensions because of misapprehension of the significance of murmurs, particularly when these murmurs were associated with the phenomena I have described. The same thing applies to affections of the nervous system. We often find this type of case called "neurasthenia" or some other form of neurosis, and subjected to various methods of treatment based upon an erroneous conception of its nature.

Furthermore, the necessity of recognising the nature of the phenomena which lowers resistance is seen in the tests which are recommended by the military authorities for determining the fitness of a man. To ascertain the functional efficiency of the heart certain exercises are enjoined. If, in response to these, there is an increase in the rate of the heart or of the breathing, it is assumed that the organ is impaired. The evil symptoms are taken as indications of such impairment. If the principles I have been enunciating be grasped, it will be seen that it is not the heart condition that is being tested by these exercises but the susceptibility of the heart to stimulation. In some cases the increased rate may represent cardiac inefficiency, but in the vast majority of cases it represents nothing of the sort, for the

cardiac irritability is but one of many phenomena the detection of which would afford a clue to the real nature of the trouble.

I have had plenty of experience showing the widespread harm of this limited study of patients' symptoms. I have been frequently consulted by men who have been rejected for the army and pensioned because of a misconception of their symptoms. I saw recently a man who was invalided out of the army and told he had got aortic disease, and that his heart was so damaged that he would never be able to undertake any occupation requiring physical effort. He was given a full pension. When I saw him he was leading a miserable existence, creeping about a few hours a day. He was easily tired, and he attributed his exhaustion to his heart complaint. His heart was easily stimulated to rapid action, and there was present a systolic murmur at the base. When I tried to assure him that there was no aortic disease and that his heart was perfectly sound, I found it was impossible to convince him. When in the army these sensations of exhaustion came on and the army doctors had detected the murmur and called it aortic disease and had treated him for a time in bed and then invalided him out. The pensions doctors had repeatedly confirmed this view of his condition, and had backed up their opinion by giving the largest pension allowance. Is there little wonder that this man cannot be convinced as to the true nature of his condition? He is made a miserable wreck on account of a defect in medical knowledge—namely, ignorance of the nature and significance of symptoms.

In a careful inquiry into the origin of ill-health in over 2,000 soldiers I found that in the case of about 80 per cent. the first onset of their illness began with some complaint of an infectious nature, such as measles, influenza, trench fever, typhoid fever, malaria, dysentery, or "P.U.O." In other cases one could gather that the onset was due to an ill-defined illness suspiciously like an infection.

In a number of cases there was no history of infection, and the onset of the illness seemed to be due to a variety of circumstances. Some of the men were weakly before they entered the army, and the unaccustomed strain had seemingly been the cause. Others, originally quite healthy, had been exposed to a long and continued bodily and mental strain; want of rest had evidently been the provoking agent in these instances.

The history of the origin of these complaints and the manifestation of ill-health accorded with the experience of civil practice. We repeatedly meet with patients who, on recovery from a febrile illness, suffer in the same way for varying periods.

CHAPTER XI.

ORGANIC REFLEXES.

55. *Vomiting.*

56. *Dyspnœa.*

57. *Secretory Reflexes.*

58. *Cardiac Reflexes.*

59. *Vaso-motor and Pilo-motor Reflexes.*

There are a number of reflex acts, apart from the viscero-sensory and viscero-motor reflexes, produced by the stimulation of centres in the spinal cord and medulla from a viscus, as shown in the diagram of multiple reflexes (Fig. 12, page 81). These acts may be very complicated, bringing into play a large number of subsidiary centres as in the reflex act of vomiting, or they may result in the stimulation of some gland as the salivary glands or the kidney. Many of these reflex acts are obscure, as the vaso-motor, and there are probably others we have not yet attained the means of detecting. I refer here to a few of these reflexes, to draw attention to a field of observation and not to give a full explanation—which, indeed, I am not capable of doing.

55. Vomiting.—Vomiting is due to the stimulation of a centre in the medulla, and this may be played upon from a great many sources, as from irritation of the stomach, from disturbances in the brain, impressions made on the senses of smell and sight. It is frequently set up reflexly from stimulation of the viscera of the abdominal cavity as in affections of the liver or bile ducts, kidney, ureter, uterus, ovaries, testicles. Its occurrence with contraction of non-striped muscle is a curious feature. In labour an attack of vomiting may be induced at the same time as a uterine contraction. Colic due to renal calculus and gall-stone—the pain arising from contraction of the ureter or gall duct—is often accompanied with vomiting. This association of vomiting with the contraction of hollow muscles, so common in abdominal organs, never occurs in affections of the heart or lungs, nor in affections limited to the bladder or rectum. I do not remember ever seeing vomiting arise as a reflex in heart affections, nor for that matter from a lung affection. One may get vomiting from the stress of coughing, as in phthisis or whooping cough, but it is doubtful if it arises as a reflex from stimulation of the lungs or pleura. In acute febrile conditions vomiting may arise, as in kidney disease, from some general poisoning effect.

56. Dyspnœa.—The centre for respiration is also in the medulla, quite close to the vomiting centre. Dyspnœa may arise directly from the prevention of the entrance of air into the lungs, or because the blood does not take up a sufficient amount of oxygen. It may be excited reflexly also, as seen

on the application of a peripheral stimulus (immersion in cold water causing a deep inspiration). In affections of the lung, as pneumonia, pulmonary apoplexy or infarcts, intense dyspnœa may arise, far greater than the mere occlusion of the air cells would account for, and it is generally assumed that this breathlessness is due to a reflex stimulation of the respiratory centre. Thus I have seen a patient seized with an attack of pulmonary apoplexy of small extent, and breathlessness of great severity supervene. After lasting a few hours the dyspnœa would suddenly cease, and the patient breathe comfortably. Some forms of asthma are difficult to explain. Some seem to be due to a peculiar sensitiveness to certain proterds, emanations from animals or flowers. Others are due to reflex stimulation from different parts of the body. The mechanism by which attacks of asthma are produced is still obscure. The condition called cardiac asthma is usually induced after a long apnœic period in one having Cheyne-Stokes breathing. Its character is similar to attacks of asthma arising from other causes, and it yields often to an injection of morphia. Breathlessness in response to effort is of great value in estimating the functional efficiency of the heart.

The possibility of a reflex spasm of the bronchial muscles should be kept in mind, in view of the fact that all non-striped muscles are liable to be played upon, and a prolonged contraction produced.

57. Secretory Reflexes.—When the stimulus from a viscus reaches a part of the spinal cord where arise nerves supplying glands, increased flow of secretion occurs. This is best seen in the kidney and

salivary glands. In a number of cases of angina pectoris the pain may extend to the jaws, and the saliva may dribble from the mouth. A similar reflex affects the kidney. Some individuals, after an attack of severe pain, as angina pectoris or headache, or after some stimulation of an organ, such as paroxysmal tachycardia or mental excitement, have a desire to micturate and pass a large quantity of pale urine of low specific gravity. These two reflexes are due to stimulation of centres in the medulla. Wherever the nerve centres supplying separate organs are in close approximation, the stimulation of one viscus may affect another. In many cases of sub-acute appendicitis, for instance, there is frequent micturition though the appendix may be situated at some distance from the bladder.

From the consideration of these organic reflexes it is clear that there must be some special connection from such remote organs as the testicle and ureter (severe vomiting may occur in orchitis and in renal colic) and the medullary centres, probably by some special path in the spinal cord. In certain cases the stimulus may reach the medulla by the afferent fibres of the vagus.

58. Cardiac Reflexes.—Of all viscera the heart is the most sensitive to stimulation, and the result of stimulation is most readily recognised. This readiness to respond to stimulation is necessary to the demands of the economy, for it is on this account that effort can be undertaken with ease and comfort, the heart rate increasing with the demand made by effort. The heart rate is readily susceptible to so many influences that it is often impossible to deter-

mine the mechanism by which its changes in action are brought about. Mental impressions have so powerful an effect that reactions playing first upon the mind may secondarily affect the heart, and it is difficult in many cases to tell whether the heart's stimulation is direct or secondary to the mental stimulation. Temperature has also a very marked influence on the heart apart from the toxins which cause the rise of temperature. Toxins may at the same time have an influence on the heart, so that it is impossible in many cases to tell how much of the heart's reaction is due to the rise in temperature, and how much to the infection. Experimentally it is known that by such means as pinching the stomach wall, reflex stimulation of the heart takes place through vagus excitation, and even the act of swallowing in man can sometimes be shown to affect the heart. Hence it is often assumed that many abnormalities in rate and rhythm of the heart are of visceral origin, and this may be so, as one sometimes finds certain irregularities increased by stomach disorders. Nevertheless one has to be very careful before accepting such conclusions, as a very great many abnormalities in the heart's action are attributed to reflex stimulation when the real cause is in the heart itself. There is a curious complex which gives rise to sensations of distress when the heart muscle is exhausted. When effort is carried on till distress is produced, the suffering is, as a rule, due to one of two conditions, breathlessness or a sensation of pressure and suffocation over the upper part of the chest, accompanied by pain in many elderly people or others suffering from certain forms

of heart disease, giving rise to what is called angina pectoris. It is this mechanism which restricts the young and healthy in effort as well as the elderly. The difference is that from childhood to vigorous manhood the field of response is continually expanding and after middle age it is continually diminishing.

59. Vaso-motor and Pilo-motor Reflexes.—The peripheral circulation is also susceptible to reflex stimulation through the influence of the vaso-motor nerves. Except in flushing and the redness of the face in acute pulmonary affections and fevers, vaso-dilator reflexes are not often recognised. Vaso-constrictor effects are more common though they have not been sufficiently investigated. Many people suffering from toxemia from intestinal stasis or after a febrile illness (such as malaria), develop a tendency to spasm of the vessels of the fingers, resembling Raynaud's disease.

Vaso-constriction is often accompanied by the pilo-motor reflex, and a confusion may arise in distinguishing the sensations which that produces. Thus the sensation accompanying the appearance of "goose-skin" is usually put down as a goose-skin sensation. Goose-skin is due to the contraction of the muscles attached to the hair roots, and, doubtless, their contraction does give rise to a sensation as when one feels the hair rise on the scalp. But the curious chilly sensation is due to a vaso-constrictor effect, for it can be felt in regions where there are no pilar muscles, as on the ulnar border of the hand. The explanation I suggest is that the stimulation which causes the pilar contraction causes also a vaso-constriction, for the

pilar and vaso-constrictor nerves both belong to the autonomic system, and are associated in their origin and distribution. This association is well brought out in the following experiment. If in a suitable case the skin under the nipple be given a smart rub with a piece of flannel, the goose-skin will be seen to arise over the part rubbed, then to spread up the chest to near the clavicle, and on to the inner side of the upper arm and forearm. At the same time the individual may feel the curious chilly sensation passing from his chest into his arm and to the ulnar border of the hand. The reason for this distribution is that the stimulus produced by the rubbing has reached in the spinal cord the centres of origin of the pilo-motor and vaso-constrictor nerves, and passed up this region for some little distance. That this is so can be inferred from the fact that the pupil will be seen to dilate at the same time. The dilator pupillæ nerve, according to Langley, leaves the cord at the place where this stimulation has taken place—that is to say, by the upper thoracic nerves. In one instance, a patient described always a chilly sensation in his cheek when I tried this experiment on him, and Sherrington says that in stimulating the sympathetic fibres issuing with the third thoracic nerve in the monkey, he produced elevation of the hair of the cheek.

The pilo-motor reflex is of two kinds, one local appearing after the skin is rubbed and limited to the part rubbed, the other reflex spreading widely. The latter cannot always be produced.

Chapter XII.

PRELIMINARY EXAMINATION OF THE PATIENT.

60. *The Patient's Appearance.*
61. *The Patient's Sensations.*
62. *Facial Aspect.*
63. *The General Condition.*
64. *A Review of all the Organs.*

60. The Patient's Appearance.—Before entering upon the physical examination of the patient, the physician ought to obtain a clear and comprehensive appreciation of the patient's own sensations. I therefore wish to insist upon the importance of the preliminary examination, which may be of more value in arriving at a correct estimation of the patient's condition than the most elaborate methods of physical examination. The attempt to appreciate the patient's condition should begin when first he presents himself. On his appearance in the consulting room, his bearing, his gait, the condition of his respiration, the colour of his face, any nervous peculiarity in his manner of speech and behaviour, and so forth, should be noted. If he is in bed, note the position he assumes, and any change in his colour or respiration in response to such exertions as talking or turning over. By habit one unconsciously

notices these things, and as the examination proceeds, first one trivial matter, then another, may arise, which helps materially in guiding the examination, and in forming the final opinion.

61. The Patient's Sensations.—After ascertaining the patient's name, age, and occupation, ask him to describe briefly his chief symptoms. After this inquire into the history of any previous illnesses or circumstances that may have a bearing on his present condition, as the nature of his work, condition of worry, bygone adventures, and hereditary pre-disposition. The data thus elicited will serve as a guide to a further inquiry into the symptoms of which the patient complains. This should be undertaken with the greatest minuteness, and the answers should be precise and definite. When the patient refers to his sensations, get him to indicate the location by placing his hand over the region, and on no account be content with his assertion that his sensation has been felt in some viscus, as the stomach, heart, bladder. When any disagreeable sensation as pain is complained of, get a clear knowledge of the very earliest circumstances under which it was produced, the situation in which it was first felt, and the areas into which it spread. In the same way, if it is breathlessness, the first sign of its appearance and the circumstances that induced it. In putting the questions the doctor should have a definite purpose in view, based on the statements made, but the questions must not be put in such a manner that the patient will divine the drift. It may be necessary, however, to ask leading questions, when it is suspected that other symptoms may

have been present which the patient has overlooked. For instance, I have found patients dwell upon symptoms referable to the epigastric region and assumed to be gastric in origin; further inquiry as to whether there had been any pain in the shoulder has frequently brought forth the answer that severe pain had been felt on the top of the right shoulder, but it was thought to be rheumatic or neuralgic. The recognition of this pain then leads to the suggestion that all the symptoms may be due to gall-stones. In the same way, in obscure cases of pain in the lower part of the abdomen, the question whether the testicle was ever sore and tender has sometimes brought out the answer that the breeches seemed at times too tight, and were supposed to be the cause of the testicular pain. The presence of this testicular pain in such cases is often suggestive of renal calculus.

It will be frequently found that the symptom, such as pain even of the most severe type, is described so vaguely that no definite idea can be obtained in regard to its manner of onset, site, or radiation. In such cases, if the patient be asked to note these particulars next time the suffering arises, he will often be able to give a very clear and instructive account of his symptoms.

I have said that a patient's answer that pain, or any other sensation, was felt in an organ should never be taken. I may add a warning to the doctor not to make a note of the sensation by attributing it to any viscus; thus, a pain should not be noted as felt in the heart, stomach, liver, or lungs, but only in the region indicated by the patient's hand, for

it will probably be found, on later examination, that the disease was not in the supposed viscus. In other words, he should make no notes that might prejudge the nature of any symptom until he has all the evidence before him. The results of this inquiry will be a guide in the physical examination of the patient, when corroborative evidence may be found in areas of hyperalgesia of the skin and muscles, in contracted muscles, or in functional or structural symptoms in certain of the viscera.

62. Facial Aspect.—The first glance may at once dispel the consideration of a large group of complaints, as when a face is healthy-looking and well-nourished there is no need to fear the presence of any malignant or exhausting complaint. When there is an absence of this healthy tinge the recognition of faint and subtle changes is useful. A slight duskiness of the cheeks or lips indicates imperfect aeration of the blood, and leads first to the consideration of the pulmonary or circulatory condition. A faint tinge of yellow in the duskiness raises the suggestion of liver engorgement. This faint yellow tinge is present in many conditions, as in pernicious anæmia, malarial cachexia, and the cachexia of malignant disease. A mere suspicion of jaundice of the skin and conjunctiva, as in certain cases of gall-stone disease, may give to the face the suspicious look of a malignant cachexia, and so also will certain forms of heart failure, particularly that form which is often accompanied with wasting. In the latter case the evident heart trouble gives a key to the nature of the enlarged liver, which is usually present. A dirty greyish aspect is sometimes seen in aortic disease.

Pallor is a common feature, and while it may indicate an anæmia (as chlorosis), yet it is natural to many families, and one not infrequently sees such people undergoing treatment for "anæmia." In elderly people the pallor may indeed be associated with various complaints, and it is often difficult to tell what importance should be attached to the symptom. I think on the whole the presence of a sallow tinge is the most constant sign of malignancy—bearing in mind what I have just said of the presence of a slight jaundice in heart affections and gall-stone. When people past the middle age suddenly develop a pallor, the sign is one of grave significance, and may be the first clue to the beginning of some malignant affection (pernicious anæmia). Other conditions should be recognised, as the flushed turgid countenance of Graves' disease. Staring eyes, while manifestly indicating the nature of the complaint, may not be very distinctive, but a slight prominence, which may momentarily increase while the patient is being questioned, may be detected.

It is not possible here to detail the many other instructive signs which the facial aspect presents, but I quote the foregoing as being the most common, and would insist on the routine study of the face all the time the patient is being questioned. As a disease progresses the facial aspect should be watched. In some, particularly in children, a sunken expression may appear in the course of an attack of diarrhœa or pneumonia, due to the shrinking of the contents of the orbit and of the cheeks—often heralding a fatal issue. In the course of typhoid fever the dull look of indifference

may gradually be seen to creep over the face. A gradual change in colour may be imperceptible to the doctor who sees the patient day by day, but is marked at once by one who sees the patient for the first time, and this change—a slight pallor, or a slight yellow tinge—may be the earliest sign of a malignant disease (pernicious anæmia, cancer).

63. The General Condition.—It is undoubtedly a misfortune that the study of what is called "temperaments" has fallen into disuse. My own experience tells that the neglect of this basis of observation is continually leading physicians and surgeons astray. This is particularly the case with those who devote themselves to some speciality. The possession of certain temperaments, particularly the neurotic, leads to exaggeration of the reflex symptoms, and a trifling complaint is thus often mistaken for something more serious. We find such patients passing from one specialist to another, each one attributing the complaint to the fault of some organ which came under his special purview.

Although it may not be possible to differentiate exactly the six temperaments of Laycock (nervous, sanguine, phlegmatic, bilious, lymphatic, and melancholic), yet the consideration of each individual's temperament should help us to estimate at its due value the patient's symptoms and the account of his or her sufferings. While we may not be able to classify temperaments with accuracy, yet in every case the mental attitude of the patient to his complaints should be borne in mind. Although, in a general way, each individual is so constituted that his temperament is a matter of inheritance, yet it

can be modified by circumstances. This is particularly seen in people who become "neurotic" in consequence of mental worry or long continuous bodily suffering.

I am not at all sure, however, that most of the states called temperament may not be acquired and the result of some obscure illness. At all events I have repeatedly seen the "nervous" temperament develop in people who have undergone long and painful illnesses. Toxins can produce many forms of mental disturbance from simple depression to insanity (as in bacillus coli infections and alcohol). The phlegmatic, bilious and lymphatic temperaments may have a similar origin, or they may be the outcome of some defective internal secretion.

64. A Review of all the Organs.—In the examination of patients the need for a thorough inquiry may demand that all organs should be inquired into. It is, however, not feasible or even necessary in the great majority of cases to make a systematic examination into the condition of each organ.

In an obscure case, and in cases where there is some complication, and when there is time and opportunity, no examination can be too careful or too thorough. But the great majority of cases with which the general practitioner has to deal do not present such complicated features, and the preliminary inquiry into the patient's symptoms gives a clue to the organ chiefly at fault, so that it is unnecessary that all the other organs should be submitted to a detailed physical examination. It is difficult to be certain when such thorough examination may be considered unnecessary, since, through

its neglect, many ailments may be overlooked. To guard against this, many general practitioners have devised for themselves methods which serve to guide them in the detection of affections of organs other than that of which complaint is made.

In the logical and thorough cross-examination to which the patient is first submitted, a fair idea can generally be obtained of the organ or region in which there is trouble. Before examining more specially that part, inquiry should be made into the functions of other organs. These may be at fault, and may in reality be the real seat of the trouble, and the patient, in describing the more prominent features of his complaint, may have ignored some, to him, trivial sign, which the systematic interrogations may bring out. This inquiry need not be time-robbing if the physician makes his questions clear and distinct, and insists that the patient's replies should be precise and to the point. In his inquiries the physician should have some system in his own mind, so that each question bears upon the symptoms of a single organ and has a definite significance. Thus, after having exhausted the information of the particular complaint, and having observed in the course of his inquiry the general aspect of the patient, as already described, he should then carefully inquire into the condition of other organs, beginning as a rule with those related by position or function to the complaint of the patient. Step by step each organ is considered, and any that may show evidence of derangement are reserved for fuller investigation. To do this the essential symptoms of derangement of any organ must be kept in view.

Thus, an inquiry is made into the condition of the heart and circulation by asking if the breathing in response to effort is good, or if he has palpitation or breathlessness on running up stairs, beyond that which one would expect from his age and habits; into the lung condition by the presence of a cough, or of trouble in the breathing; into the digestive system by the presence of discomfort at any time before or after meals, and by the movement of the bowel; into the urinary system by the frequency of micturition, and particularly as to whether the patient has to get up in the night to pass urine. By following such lines as these, being often guided by some incident in the patient's history or appearance, it will usually be found that no essential sign is overlooked. In all cases the patient's replies must be as direct and to the point as the question asked. The tendency to prolixity, which many patients show, must be firmly repressed; a clear reply should be obtained to each question, and no question allowed to pass until the answer is obtained. The patient may be so full of his own view as to his condition that there may be some difficulty in restricting him to the subject the physician has in his mind, but if the physician will but be persistent in his method—having a clear conception in his own mind as to what he requires—the patient can usually be induced to give clear and coherent replies. According to the tenor of the replies the subsequent physical examination will be guided. In drawing conclusions from the results of the examination it is necessary to consider the bearing of any abnormality, or supposed abnormality, on the sufferings of the patient. It often

happens that the complaint from which the patient suffers is obscure, and the cause difficult or impossible to determine. Should some other abnormality be present, which is easily recognisable, then there is a great tendency to attribute the symptoms to this demonstrable abnormality.

A patient of mine, suffering from some obscure abdominal complaint, consulted a gynecologist, who, finding an ovary which he considered too large, put all the trouble and suffering down to this, and removed it. Obtaining no relief, the patient sought the opinion of a surgeon, who, finding a slight dilatation of the stomach, put all the symptoms down to that, and performed a gastro-enterotomy, also without relief to the patient. In youth and in old age certain forms of irregularity of the heart are present in so many people that they may almost be looked upon as normal, and have no important bearing upon the patient's condition, yet when these patients are found suffering from any obscure condition, as weakness, fainting, or even epilepsy, the diagnosis is often based upon this irregularity, though its nature is not understood. To many minds it is satisfying to detect an abnormal sign, even though it has no connection with the complaint from which the patient suffers. This tendency to be misled by the detection of an abnormal sign is seen very frequently in patients who may have a cardiac murmur. All sorts of symptoms can be referred back to this, and treatment for an innocent murmur is often undertaken with unnecessary energy to the neglect of the essential cause of the patient's suffering.

CHAPTER XIII.

AFFECTIONS OF THE DIGESTIVE ORGANS.

65. *The Nerve Supply of the Digestive Tract.*
66. *Distribution of Sensory Symptoms in affections of the Digestive Tract.*
67. *Appetite.*
68. *Hunger.*
69. *Nausea.*
70. *Mouth and Fauces.*
71. *Tongue.*
72. *Swallowing.*
73. *Œsophagus.*

65. The Nerve Supply of the Digestive Tract.—The nerve supply of the digestive tract is derived partly from the autonomic and partly from the cerebro-spinal system. If one glances at Langley's diagram (page 59) it will be seen that the autonomic supply is derived from three regions: (1) from the bulbar autonomic division by the vagus, distributed to the walls of the gut from mouth to descending colon; (2) from the sympathetic division by the splanchnics, which supply the stomach, small intestine, and greater part of the great intestine; and (3) from the sacral autonomic division, which supplies the descending colon and rectum.

The cerebro-spinal nerve supply is limited to the oral and anal orifices. The sensations at the oral end are divided into those of common and special sensations. The sensory nerves are derived from the fifth cranial and glosso-pharyngeal, and supply the mouth, fauces, and a small portion of the upper end of the œsophagus; the exact extent has not been accurately defined. The mouth differs from the skin in sensibility, touch being less acute and less perfectly localised, though temperature and pain senses are well developed. The nerves of special sensibility (taste) in the tongue are derived from the glosso-pharyngeal, fifth, and chorda tympani nerves. The olfactory nerve, too, must be considered as an accessory nerve of digestion, for it has remarkable effects in stimulating reflexly the salivary and gastric glands, and also in the appreciation of flavour. It has also, at times, a powerful effect in inducing attacks of vomiting.

The distribution of the cerebro-spinal system of nerves to the anal end of the gut is of very small extent, being limited to little more than the inner side of the external sphincter. So far as I have been able to make out, the mucous membrane covering the internal sphincter is devoid of direct sensation.

66. Distribution of Sensory Symptoms in affections of the Digestive Tract.—The nature of the nerve supply explains the character of the sensory symptoms evoked by affections of the digestive tract. Limiting the study at present to the subject of pain, it will be found that from the top of the œsophagus to the anus there is, in the great

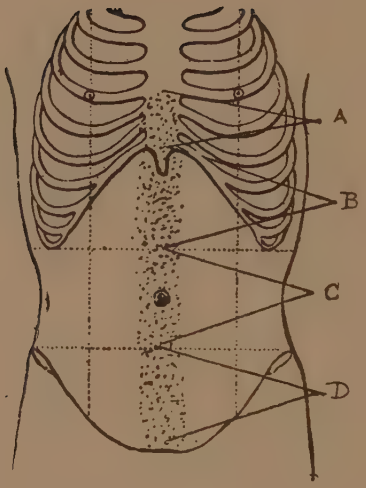

Fig. 13.

The shaded parts show the areas in which pain is felt in affections of the digestive tube. Peristalsis passing through the whole digestive tube may give rise to pain felt descending in the shaded area.

A. Area in which pain is felt in affections of the œsophagus.

B. Area in which pain is felt in affections of the stomach.

C. Area in which pain is felt in affections of the small intestine.

D. Area in which pain is felt in affections of the large intestine.

majority of instances, a limitation of the distribution of the pain to an area extending down the centre of the body from about the middle of the sternum to the symphysis pubis (shaded area in Fig. 13).

If pain be produced by stimulating the œsophagus, as, for instance, by a hot drink, the pain is always referred to the region over the lower part of the sternum. Usually this pain is supposed to be perceived "in the œsophagus," but if this sensation were in the œsophagus there is no reason why it should not be felt better in the back, for the œsophagus is nearer the posterior cutaneous surface than the anterior. Pain arising from the stomach is limited, in the vast majority of cases, to the epigastrium. The best idea of intestinal pain is found in watching a case of peristalsis of the bowel. A painful peristalsis may start with pain referred to the lower part of the epigastric region, then it slowly descends with a grinding intermitting severity until it reaches above the pubes, when the call to defecate becomes urgent, and relief is at once found with the expulsion of a loose motion. In such an instance the movement has affected the whole intestinal tract, and the peristaltic waves have passed into all quarters of the abdominal cavity, yet the pain has descended in an even and unvarying direction down the centre of the abdominal wall.

It is well to remember this feature of pain due to peristaltic contraction of the gut, for it will be found of frequent diagnostic importance in solving the source of severe colic-like pains. As already remarked, contraction of non-striped muscles is the most frequent cause of violent visceral pain, and, as

a rule, when the pain is violent, it can be very accurately localised. This limitation of the pain to the middle line of the body is characteristic also of the pain of other hollow viscera, as the gall-ducts, uterus, and bladder, while the pain of renal colic (contraction of the ureter and pelvis of the kidney) is distinctly unilateral.

67. Appetite.—All actions that are performed periodically or intermittently, in which volition participates, are accompanied by sensations which make known the time when the act has to be performed. These sensations are in themselves not unpleasant at first, but are accompanied by a desire to perform voluntarily an act which will gratify that desire. Thus, if the breath be held the desire to breathe is not painful, but there is a longing for the sensation of full inspiration. So, in regard to the call for micturition and defecation, the sensation is one calling for the gratification of a sense of relief. To this category belongs the desire for nourishment, liquid or solid—the appetite.

Appetite itself is a sensation so vague that no definite description of its mechanism can be given, though it is probably dependent on the digestive glands in the mouth and the stomach. The consciousness of appetite is accompanied by increased secretion of these glands—so much so, that even the contemplation of a satisfying meal may cause the "mouth to water." The appetite or desire for food may be increased by the sight or odour of tempting viands, or even by the mental contemplation of them. and an abundant flow of the gastric juices may result from such stimulation.

The appearance of a normal appetite follows the efficient absorption of food and its expenditure in the production of energy. Thus it is seen at its best in those who work in the open air. The gratification of an appetite being amongst the most elemental of pleasures, the presence of appetite is a rough indication of health. Man's environment so often prevents its display that means are taken to excite an appetite by providing food in a manner that will supply the craving.

These artificial aids, used to create appetite, diminish the value of this sensation as a diagnostic aid. The loss of appetite, as seen in animals (horses, cattle), is the most important sign of impaired health, and its return is an indication of restoration to health. In man also it has significance, but, as man resorts to all sorts of artificial aids, this significance is often diminished. Still the question of loss and return of appetite affords valuable aid in diagnosis. When an individual loses his appetite it may be taken as an indication that all is not well. The loss of appetite may, with reasonable probability, be referred to a diminished excitability of the secretory glands or their nerves. The secretory reflexes which are associated with appetite may be played upon in a great variety of ways, as by mental excitement, impaired metabolism (as in enforced rest), increased temperature and the agents inducing it, affections of the digestive tube and other organs. The symptom of anorexia, loss of appetite, merely indicates, therefore, that there is something wrong in the economy. Further examination may reveal the cause, and the behaviour

of the appetite may often prove a safe guide as to the progress or retrogression of the ailment.

Certain results follow the loss of appetite; the tongue becomes furred, the mouth unpleasant from the lack of the mechanical friction of the tongue against the palate and the absence of juices from the inactive glands, abdominal discomfort arises from the accumulation of flatus, and the bowels are inactive from absence of stimulus.

An increased desire or craving for food (boulimia) may arise during convalescence from a long illness, such as typhoid fever. The craving is probably due to the tissues losing the poisoned fluids, returning to their normal state, and requiring suitable nourishment of which they were deprived during the illness. An abnormal appetite may be one of a group of symptoms, referable either to the nervous system, as in hysteria, or to conditions in which there is no sign of mental defect, as in chlorosis, diabetes mellitus, intestinal worms. Enormous quantities of food may be taken by those who are thus affected.

Craving for certain forms of food is a frequent sign, but there is often a craving for things that are not food, and that are not digestible. This perverted appetite may arise as a matter of habit, for the custom of eating earth (geophagy) is prevalent among natives of widely separated countries. In some cases the earth may contain nutritious properties, but in many cases it is used, not for its nutritive value, but merely for the gratification of a perverted taste, or to satisfy the craving in the absence of proper food. Perversion of appetite is common

amongst the insane, but it is also present as a bad habit amongst others, as children, chlorotic females, pregnant women, and others who have no particular ailment. The objects eaten or swallowed are of the greatest variety, as chalk, coal, earth, plaster, ashes, pebbles, etc.

68. Hunger.—While the anticipation preceding the performance of a periodic act may be pleasant from the prospect of gratification, the undue delay of performance results invariably in the sensation becoming one of distress. Abstinence from food may convert the sensation of appetite into one of hunger, and hunger implies distress, and when pushed to extreme is probably the most clamant of all desires. Hunger becomes more than a mere excess of appetite. Appetite is probably, as already stated, the outcome of the active stimulation of certain digestive glands, while hunger is the craving of the whole body for nourishment, and the digestive tract, with its limited sensations, is the vehicle for the sustenance of the whole economy. This is seen by the fact that hunger may exist when the stomach is full, the appetite gratified, but the food prevented from reaching the tissues in consequence of an intestinal fistula. Apart from hunger due to starvation, an increased craving can be induced by measures taken to stimulate the appetite, by cooking, and the various means of providing "tempting bits," and this may be carried so far as to become a perverted habit. Perverted tastes may arise, however, from custom, or as a symptom of disease.

69. Nausea.—The unpleasant sensation, nausea, is often associated with loss of appetite and certain

affections of the stomach. Though it often comes on at an early stage in the act of vomiting, it may arise without vomiting, just as vomiting may occur without any previous feeling of nausea. It is associated with the digestive function, and its appearance is accompanied by a stimulation of some digestive glands, as shown by profuse flow of saliva. In certain affections of the stomach, as in the gastric catarrh of alcoholics, it is the most distressful symptom, occurring usually after a long fast, as in the morning before food is taken. It may arise suddenly from some reflex cause, as from a bad odour, an offensive sight, or the appearance of unattractive food. In addition to the disagreeable sensation there is often some spasmodic contraction of certain muscles, as the diaphragm with closure of the glottis, as in the preliminary stage of vomiting. Accompanying the nausea there is often a feeling of faintness, the pulse becomes soft, weak, and rapid, and the face blanched, due in all probability to the action of the vagus diminishing the force of the heart beat, and producing a vaso-motor depression.

70. Mouth and Fauces.—The pain complained of in affections of the mouth and fauces may be local or referred, or both. Local pain in the mouth may be present in inflammatory affections of the mucous membrane. In toothache it may be felt not only in the affected tooth, but in neighbouring teeth, and the jaw may become painful and tender (Fig. 4, page 54). The pain may be felt so severely in places apart from the offending tooth that it requires some care to detect which tooth is at fault. The pain may be referred to parts outside the mouth, in the

cheek, or in some portion of the head, and the skin may become very hyperalgesic. It is necessary in any case of "neuralgia" of the face and the head to carefully examine the condition of every tooth.

The fifth cranial nerve is particularly liable to stimulation from affections other than those arising from the mouth, and the presence of pain in the distribution of the fifth nerve may be due to a variety of causes. The most striking of these conditions is when there is some distinct affection of the nerve itself or the nerve ganglion, in the disease called trigeminal neuralgia or tic douloureux. Before the full character of this complaint is revealed in all its terrible characteristics, there is a period in which it resembles so closely the characters of a toothache that at first it is almost invariably mistaken for this complaint, and one decayed tooth after another is removed. The pain continuing to recur, the dentist next attacks the sound teeth, and not infrequently every tooth is removed, yet pain continues to recur in the edentulous jaw. Relief may be found after the removal of one or more teeth, but, as with the operation for nerve stretching, it is but temporary. It is not possible in the early stages to distinguish between a case of true tic and a toothache. In both the pains may recur at intervals, and, when there is hyperalgesia of the skin of the cheek in toothache, the resemblance between the two conditions is very complete. Thus, stroking of the hair may be exquisitely painful, and may bring on a spasm of pain. When one decayed tooth after another is removed with no lasting benefit, then the true nature of the complaint may be suspected, but as one is loth to come to the

conclusion that the case is one of true tic douloureux, the teeth extraction continues.

Another instructive form of pain occurs in certain forms of angina pectoris, where the pain is not only present in the chest and arms, but may be felt in the lower jaw and throat. The pain of angina pectoris may even start here, and be limited almost entirely to this region. The feeling is described as a sense of intense soreness along the lower jaw, akin to what is felt in some forms of toothache. The nerves supplying the fauces, and the voluntary muscles engaged in swallowing, may also be hypersensitive, so that the patient has a good deal of pain in swallowing. In rare cases, after a severe attack of angina pectoris, the patient may complain of pain in swallowing for weeks after the attack has passed off. Doubtless, in such cases, the violent stimulation has reached the medulla and upper part of the cord by the vagus, and the stimulation has affected the sensory cells in the neighbourhood and left an irritable focus, as witnessed by the hyperalgesia of the muscles and mucous membrane shown in the act of swallowing.

Inflammatory affections in the fauces often cause great pain in the act of swallowing. When the tonsils are acutely inflamed the increased secretion of mucus continuously excites the act of swallowing and causes great distress. The pain is felt not only in the inflamed parts, but extends into the sides of the neck, and up into the ear. The skin of the neck behind the jaw may become hyperalgesic, and frequently there can be detected enlarged and tender glands behind the jaw.

A number of patients may complain of pain on swallowing, and when careful investigation is made it will be found to be due to a form of infection very common amongst those who use false teeth where the utmost cleanliness is not observed. The patient frequently complains of a sore throat, and if the fauces be inspected a slight redness of the pillars can be detected. It the patient wears a plate on the roof of the mouth, and this be removed, the underlying mucous membrane will be found swollen and red, and from this place to the fauces there can be detected an extension of the inflammation in the form of small red dots. Sometimes the surface of the mucous membrane, under the plate, may be covered with patches of thrush, and an infective process may extend to the parotid and sub-lingual glands, causing severe inflammation and swelling of these glands. Inspection of the mouth may reveal other abnormalities, as ulcers.

A very interesting instance of referred sensation is seen in passing a bougie into the eustachian tube. When a catheter is passed into the eustachian tube for the purpose of insuflation, the sensation produced by the catheter is referred to the back of the nose. If a bougie be passed along the catheter into the eustachian tube, the sensation is at first referred to some place between the back of the nose and the ear. If the bougie be pushed further in, a part is reached where the sensation is suddenly referred to the neck behind the jaw. This transference of the sensation is doubtless due to the parts being supplied by nerve fibres from different sources—the exact nature of the supply I am unable to determine.

71. Tongue.—In health the tongue should be evenly and steadily protruded, moist, and of a slightly translucent pale red colour. A tremulous tongue should lead to an inquiry into the alcoholic habits, and an unevenly protruded tongue to the question of paralysis.

The principal cause of a furred tongue is absence of friction, usually due to deficiency of saliva and insufficient mastication. Too much stress has been laid upon the supposed association of the furred tongue with certain "catarrhal" conditions of the stomach and bowels. A person with no appetite has a furred tongue because he does not masticate. A person who bolts his food, or who washes his food into his stomach by drinking while eating, or who lives on "slops," has a furred tongue from the same cause. The posterior third of the tongue in some is always furred, and in these it will be found that the palate is high and arched, so that the tongue does not come into contact with the roof of the mouth. Mouth breathers also have a tendency to a furred tongue, for the playing backwards and forwards of the air over the tongue dries it, and favours the formation of the fur. This is especially the case in fevers where the hot air passing over the tongue dries it. This tendency is further increased by the absence of mastication—the patient being so often fed on slops. In fever a fur may appear in spite of all precautions. A very striking prognostic sign may be found in carefully watching the tongue in febrile states, for the earliest symptom that the fever is about to yield may be the appearance of a small clean spot on the tongue.

72. Swallowing.—The act of swallowing, so far as it is carried out within the region of distribution of cerebro-spinal nerves, is a voluntary and conscious act; but as soon as the bolus passes beyond into the region supplied by the autonomic nervous system, it becomes involuntary and unconscious. During the act the respiration is inhibited and the levator palati raises the palate and shuts off the nasal cavities. Bilateral paralysis of this muscle, as after diphtheria, leads to fluids regurgitating down the nose during the act of swallowing.

Pain accompanying the act of swallowing is due most frequently to some inflammatory infection of the tonsils or fauces. It is generally referred to the neck behind the jaw, or up into the ear. Inspection of the fauces will generally reveal the cause. In rare cases, as already cited, there may be a hyperalgesia of the mucous membrane and of the muscles with a good deal of pain on swallowing.

There is sometimes shown a curious relationship between the tonsils and the nerve supply of the external ear. In a number of cases I have found during a tonsilitis an attack of herpes zoster occur, the eruption appearing on the lobe and pinna of the ear. This has occurred so frequently that the association is more than casual, and I suspect some intimate central relationship between the nerve supply of these parts. Herpes zoster has been shown by Head and Campbell to be due to a destructive inflammation of the ganglia of the sensory root, and it is difficult to explain the definite relationship of the tonsilitis and the herpes on the ear, but the fact is one worthy of consideration in the investigation of

the relationship of the viscera to the cerebro-spinal nerves.

73. Œsophagus. — The nerve supply of the œsophagus being derived entirely from the autonomic system, we get no direct response to stimulation. Pain arises rather easily from stimulation, especially, as everyone has experienced, on the drinking of hot fluids. The pain thus excited is referred distinctly to the front of the chest, and although the heart and lungs are interposed between the site of pain and the œsophagus, and although the œsophagus itself is nearer the back of the chest than the front, everyone unhesitatingly refers the pain as being felt in the œsophagus. Nevertheless, after a good many observations, I have come to the conclusion that the laws governing the sensibility of the œsophagus are the same as those governing the sensibility of the other portions of the digestive tube, and that the œsophageal pain is a referred pain and not direct. That its sensibility is different from that of the stomach is, I think, undoubted. The pain in swallowing hot fluids, for instance, is more readily induced by the œsophagus than by the stomach. Also the stomach contents, though giving rise to no sensation when in the stomach, may cause great discomfort when they regurgitate into the œsophagus, and it is for this reason that I assign the disagreeable sensation of heart-burn to the acrid stomach contents escaping into the œsophagus. (See page 140.)

Some recent observations by Hurst, Cook and Schlesinger lead them to the conclusion that the sensation of heat and cold on swallowing fluids is actually felt at the lower end of the œsophagus, but

their observations do not disprove, as they seem to think, the referred character of the sensation. The view I hold that the sensations of heat and cold are really due to a reflex stimulation of the peripheral vaso-motor nerves is not disproved because in some cases the sensation is felt "deeper" than the skin; and, although I am far from asserting that the hypothesis I put forward is absolutely correct, the matter is not the simple one these observers seem to imagine.

In some cases, particularly in females of a neurotic habit, the moment a hard piece of food, as a small crust of bread, or even a soft bolus or fluid, touches the upper part of the œsophagus, the œsophagus at once contracts with such violence and persistence that no food can be taken for some time. Sometimes a small portion of food may be grasped in the spasm, when the spasm may last for hours, and the patient be in great suffering on account of the difficulty in breathing and the excessive flow of saliva that cannot be swallowed. The forcible passage of a bougie or probang at once gives relief. In a large number of cases I have found the systematic passage of a bougie the best means of treatment. In some rare cases the seat of the spasm may be lower down.

In stricture of the œsophagus, if the stricture be high up the food is rejected at once, if low down it may be delayed for some time. Sometimes the œsophagus wall contracts strongly, and, as in obstruction of the bowel, pain may arise from the peristalsis, and is always referred to the front of the chest, at a level near that of the stricture. Great care should be taken in all cases in the passage of an exploratory bougie, lest injury be done to the walls.

CHAPTER XIV.

AFFECTIONS OF THE DIGESTIVE ORGANS (*continued*).

THE STOMACH.

74. *The Nature of the Symptoms.*
75. *The Nerve Supply of the Stomach.*
76. *The Site of Pain in Affections of the Stomach.*
77. *The Character of the Pain.*
78. *Hyperalgesia.*
79. *Superficial Reflexes.*
80. *Viscero-motor Reflexes.*
81. *Vomiting.*
82. *Pyrosis and Heart-burn.*
83. *Air Suction.*
84. *Functional Symptoms.*
85. *Structural Symptoms.*
86. *The Diagnosis of Stomach Affections.*
87. *Pain in Gastric Ulcer.*

74. The Nature of the Symptoms.—The stomach being an organ that daily makes itself known by sensations of pleasure or discomfort, forces its symptoms upon all. Considering its highly complex organisation it is a wonderfully long-suffering organ, for it not only digests food suitable for the whole organism, but it has to submit to improper

food, to the gratification of gluttonous desires, and to the caprices of perverted tastes. It cannot be wondered at that it should so often become deranged in structure and function, and that these derangements should be of various kinds.

Its accessibility has permitted many observations to be made on its functions in health and disease, and has afforded scope for the ingenuity of the physiologist, the chemist, and the clinician. Although continual progress is being made in the discovery of its properties, it must be admitted that little of practical importance has been evolved for the purpose of diagnosis and treatment of the great majority of patients. So far as the physiologist is concerned he cannot acquire the necessary information, because symptoms of disordered digestion are usually the outcome of years of improper feeding. Food unsuitable for the digestive powers of the stomach deranges the functions of its secretory glands and the structures of its walls, and it must be confessed, we are ignorant of the nature of these changes. It is for this reason that so little advance has been made in diagnosis and treatment, apart from the progress of surgical methods, and of the examination of the stomach contents. Some light may be thrown on obscure diseases by the observation of the progress through the alimentary canal of a bismuth meal by the X-rays. These methods, however, are applicable to but a very small proportion of sufferers from stomach affections.

Attempts are continually being made to classify affections of the stomach, and the lack of agreement in these classifications is merely due to the fact that

attempts are made to differentiate what cannot be differentiated. This will be realised when the nature of stomach symptoms is considered. Apart from some characteristic vomits (blood, mucus), and certain changes indicated in the position of the organ (and these refer only to a very small proportion of the cases), all the symptoms are of a reflex nature, pain, cutaneous and muscular hyperalgesia, muscular contraction, vomiting, air suction. As any adequate stimulus may suffice to produce these symptoms, and as this adequate stimulus may arise from the most varied causes, trivial or severe, it follows that there is a great similarity in the symptoms in diseases of the most varied kinds. Hence it is impossible in many cases to tell the nature of the affection; for instance, a passing simple "indigestion" arising from one indiscreet meal may present the symptoms of "gastritis" or ulceration. For this reason it often happens that no satisfactory diagnosis can be made in the early stages of a chronic stomach complaint. To ascertain the true nature of many stomach affections it is necessary to wait and observe the results of treatment and the progress of the disease. When patients come in a late stage of the complaint the peculiar features of any given disease may have become so evident that an accurate diagnosis can be made; but these form but a small proportion of the chronic cases that the practitioner has to treat.

I have already pointed out that in visceral disease certain areas in the spinal cord may become for a time so irritable that stimuli from the periphery give rise to an exaggerated response, as when the skin becomes hyperalgesic and the recti muscles

contracted. This irritable focus in the cord is of great frequency in stomach affections. Not only does slight stimulation of the skin produce pain, but a stimulus reaching the irritable focus from any source may produce pain, and it is for this reason that the ingestion of food is so frequently accompanied by pain. When pain occurs after food it must not be assumed that there is an inflammation of the mucous membrane, or that the stomach is itself hypersensitive. The ingestion of food under normal circumstances is accompanied by reflex processes which are not perceived, and pain merely indicates that there is an irritable focus in the cord through which these reflex processes pass. The lesion inducing the irritable focus in the cord may not necessarily be a stomach lesion at all, but may arise from a neighbouring organ whose reflex centre in the spinal cord is in close proximity to that of the stomach. In gall-stone colic the pain may be so violent as to invade the stomach area in the cord, and the pain arising on the ingestion of food in a case of hyperalgesia due to gall-stone disease may persist for days after gall-stone has been passed per rectum.

In true lesions of the stomach this irritable focus in the cord is readily produced, and its presence is demonstrated by the ease with which pain is induced in certain stages of digestion by the hyperalgesia of the skin and muscles of the epigastrium, and by the hardened epigastric muscles.

75. The Nerve Supply of the Stomach. — The stomach is supplied by nerves from the dorsal sympathetic and from the vagus. The origin of the

sympathetic has not been exactly determined, as the experimental attempts to find the efferent fibres that supply the stomach have not been very successful, so that the place of origin in the spinal cord is best inferred from clinical observations of the area in which the pain and hyperalgesia arise.

The epigastric region is essentially the place to which the sensory symptoms are referred, and it is the upper part of the left rectus muscle which contracts first in response to stimulation from the stomach. The nerve supply to the skin of this region comes from the sixth and seventh thoracic nerves, and the upper portion of the rectus is supplied by the sixth. When the pain is severe, and tends to radiate, it generally goes to the left of the epigastrium, but may invade the regions of the front of the chest supplied by the fifth and fourth thoracic nerves. I have seen the symptoms in rare cases resemble attacks of angina pectoris, and it has seemed to me that the cause of the pain in such cases was violent peristalsis of the cardiac end of the stomach.

The burning pain of heart-burn is generally felt over the lower part of the sternum, in the region of distribution of the fifth thoracic nerve in the chest. It has seemed to me that the immediate cause of this pain is the regurgitation into the œsophagus of the acrid contents of the stomach. The frequency with which in these cases some of the stomach contents regurgitate into the mouth confirms this view.

The result of vagus stimulation is difficult to determine in stomach cases. Pain may be felt in the neck and jaw in severe gastric colic, very like that

felt in some cases of angina pectoris, and this, I can only conclude, is a stimulus reaching the fifth cranial and upper cervical nerve centres, by means of the vagus. The brow pain felt in swallowing ice is often spoken of as a vagal reflex, but this pain arises not from the stomach, but from the back of the mouth. This can be demonstrated, in suitable cases, by keeping the ice against the soft palate, when the pain will be evoked. The same peculiar pain can also be evoked by immersing the scalp in cold water.

In rare cases vagal stimulation, excited by swallowing or by the ingestion of food into the stomach, can produce irregular action of the heart, of the nature of heart-block, or of extra-systoles.

76. The Site of Pain in Affections of the Stomach.—In 1892 I published a paper, in which I gave the results of a careful inquiry into the site of pain in 320 cases of affections of the stomach. In the analysis I found that 95 per cent. referred their pain to the epigastrium. Since that time I have kept records of some thousands of cases, with the same results. Whatever the nature of the lesion the pain is referred with great certainty to the epigastrium (B, Fig. 13, page 116). It may radiate from here up into the chest, or to the left. It is not infrequently accompanied by a pain in the back, and the patient sometimes states that the pain strikes from the front through to the back. It might be inferred from the situation of the pain that the pain itself was actually in the stomach, but one can demonstrate that it is really referred to the peripheral distribution of the cerebro-spinal nerves in the abdominal walls. Thus, in many cases, the skin and muscles in the area in

which the pain is felt are hyperalgesic, and it is but reasonable to infer that the pain felt by the patient is referred to a region where the sensory nerves are so demonstrably affected. The movements of the stomach do not cause a displacement of the pain, and when the stomach itself is shifted, as by deep inspiration and expiration, there is no accompanying shifting of the pain. In localised affections of the stomach (as ulcer), however varied the situation may be from cardiac to pyloric end, the pain in the great majority of cases is referred by the patient to some part of the epigastric region.

77. The Character of the Pain.—Although the stomach is a hollow muscular viscus, severe cramp-like pain from violent peristalsis is of rare occurrence. It will usually be found, in the long run, that the so-called "cramp of the stomach," in which there is pain of great severity referred to the epigastrium, is due to gall-stone colic. I have watched many patients for years who suffered from these severe attacks, and found that they all turned out to be cases of gall-stone disease. In later years I have had little difficulty in recognising their origin, because of the peculiar distribution of the reflex phenomena in gall-stone disease (*see* page 156). Violent cramp-like pain may rarely arise in stomach affections, but the pain tends to radiate higher into the chest, and, may be, into the jaw (vagus stimulation). More frequently the pain of stomach affections is of a dull prolonged boring character. Its position being so definitely situated in a region remote from the seat of the lesion (as in gastric

ulcer) shows that it is the outcome of a stimulation of an irritable focus in the spinal cord. The pain is therefore more prolonged, and varies little in intensity. Such a distinction of the character of the pain can usually be made, and seems to account for the persistent boring pains in gastric ulcer and in other conditions.

The relation of the pain to the ingestion of food is very variable. In some the introduction of food into the stomach causes immediate pain, or the pain may come on at variable intervals after food. When it comes on two or three hours after food, relief may sometimes be obtained from taking more food. No very certain conclusions can be drawn from this relation of pain to the ingestion of food. Attempts have been made to diagnose the position of an ulcer from this relationship, but there is no ground for such a deduction. As a matter of experience the pain in gastric ulcer may come on at any period whatever its situation. This will be appreciated when it is recognised that the ingestion of food or some stage of its digestion acts as a stimulant to an irritable focus in the spinal cord. The occurrence of the pain one or two hours after the food, with symptoms of peristalsis (as recognised by the wavy character of the pain) and with acrid regurgitations into the œsophagus, is fairly characteristic of one form of dyspepsia, sometimes spoken of as "hyperchlorhydria," in which the trouble is supposed to be due to an excessive secretion of hydrochloric acid. This form of indigestion often yields readily to suitable treatment, but it is not infrequently associated with gastric ulcer and

gall-stone disease, and this association should be kept in mind.

78. Hyperalgesia.—In addition to the pain other sensory phenomena may arise, the chief of which is hyperalgesia of the skin and deeper structures. The area which becomes hyperalgesic is the epigastric. It may be limited to a small area in the middle, but it is usually diffused with indefinite borders, extending sometimes as an irregular band round the left side to the spine.

The hyperalgesia may not be present in the skin, but in the muscles, or in the sensitive layer outside the peritoneum. This can be shown by first testing the skin and finding the sensibility normal, then pressing so that the muscle is stimulated; or by pushing the finger between the recti when the peritoneal layer may be found sensitive. Of course, in the latter case, one cannot assert that the pain is elicited from this layer alone, for the pressure may affect other structures.

79. Superficial Reflexes.—Associated with this hyperalgesia there is invariably an increase of the reflexes, superficial and viscero-motor. The superficial is demonstrated by the liveliness of the response when the skin is stimulated, the upper part of the right rectus contracting rapidly and powerfully. Not only is the increased reflex activity shown in the response to the stimulation of the skin in the epigastrium, but it is also shown by the greatly extended cutaneous field from which it can be elicited. Normally the reflex of the upper portion of the rectus muscle is obtained from an area limited to the epigastrium, but with an irritable focus in the cord the

cutaneous area, stimulation of which will cause a reflex contraction of the upper portion of the rectus, may extend as high as the axilla. The extension of this area follows some peculiar law, as responses cannot be elicited from the whole of the left chest, but only from an area extending in an irregularly shaped band up the side to the axilla.

80. Viscero-motor Reflexes.—The viscero-motor reflex is recognised by a permanent rigidity of the upper division of the left rectus muscle. This may be so slight as to be evident as an increase in the tone of the muscle and detected only on comparison with the other parts of the muscular wall of the abdomen, or it may be hard and resistant. In seeking for this reflex gentle exploration is needed to avoid the production of the superficial reflex.

81. Vomiting.—Vomiting as a symptom of stomach affection is somewhat infrequent and of very variable significance, and the most persistent vomiting may arise reflexly from other organs, as in the persistent vomiting of catarrhal jaundice, pregnancy and brain affections. As a symptom of stomach affections the frequency of the vomiting and the nature of the material vomited constitute the best evidence. An occasional attack of vomiting may arise from a great many causes. In persistent vomiting, if reflex vomiting from other organs can be excluded, some inflammatory affection may be recognised, and the possibility of gastric ulcer considered. The response to treatment is an important factor in diagnosis.

Certain characteristics at the time of vomiting give information. The morning sickness of pregnancy

and of the alcoholic is very characteristic. The vomiting, once a day, or every day or two, of large quantities is suggestive of the dilated stomach secondary to pyloric stenosis. The character of the material vomited is also of importance. If the contents of the stomach contain the food that has been taken many hours before, some obstruction to its passage is suggested. The thick viscid mucus vomited is characteristic of a somewhat violent gastritis. The presence of blood (coffee-ground vomit) is characteristic of ulceration. Inquiries should always be made for the presence of "tarry" stools. The vomiting of large quantities, sometimes with brown froth, is characteristic of dilatation of the stomach. Vomiting with a fæcal odour usually indicates obstruction of the bowel. The absence of hydrochloric acid in the vomit suggests the possibility of cancer.

82. Pyrosis and Heart-burn.—The food may regurgitate back into the œsophagus. Sometimes this is normal (merycism), and is of the nature of the return of the cud in ruminants. In certain cases, when the stomach contents become abnormally sour and acrid, strong peristalsis may produce pain with regurgitation of some of the contents into the œsophagus, and thus give rise to the painful burning sensation described as "heart-burn." This may be accompanied by the return into the mouth of some of the contents of the stomach, sometimes insipid to the taste, sometimes sour and acrid (pyrosis, water-brash). One form of this condition has received the name of hyperchlorhydria, because an excess of hydrochloric acid is present in the stomach contents,

and because it can be relieved by alkalies. But this increase in hydrochloric acid is but one of the abnormal manifestations, and excess in its secretion is not necessarily the disease, nor the cause of the symptoms, for the administration of hydrochloric acid relieves the symptoms, and the presence of hydrochloric acid in the œsophagus does not cause heart-burn. There are other acrid substances of unknown nature present which evidently excite the peristalsis of the stomach.

83. Air Suction.—Flatulence is a common complaint with dyspeptics, but true flatulence, *i.e.*, flatulence due to evolution of gases in the stomach, is relatively rare. The vast number of people who suffer from "attacks of wind," and who appear to expel large quantities with a loud noise, owe their attacks to air spasmodically sucked into the œsophagus or into the stomach. These may start with a slight feeling of distension after meals, when the patient endeavours to obtain relief by expelling wind. In this attempt air is unconsciously sucked into the œsophagus, and its noisy expulsion is supposed to be an evidence of air being expelled from the stomach. Sometimes the air is sucked into the stomach, and its expulsion is accompanied by some flatulence that was present in the stomach, and in consequence considerable relief is obtained. Some people when suffering from pain get a measure of relief by sucking air voluntarily into the stomach and then expelling it.

This air suction occurs most frequently in people of a neurotic temperament, and the attacks may come on when they are put out, worried, or

suffering from affections of other organs. When a patient complains of attacks of flatulence coming on suddenly as during sleep, it will often be found that the patient is an air-sucker. It might seem that an uncontrollable reflex would cause the air suction, for patients during an attack of angina pectoris may hold themselves in such a manner that air is unconsciously sucked in, and its expulsion is often accompanied by such relief that the origin of the suffering is put down to a stomach affection. Attacks of air suction may be stopped at once by the mouth being kept wide open by a gag. Wyllie's article in the Edinburgh Hospital Reports (Vol. I.) throws a great deal of light on the subject.

84. Functional Symptoms.—The symptoms that arise from changes in function are available in relatively few cases. Those due to alteration in the secretion are mainly limited to the recognition of an excess of mucus, or an increase or diminution of the amount of free hydrochloric acid in the stomach contents, obtained either from the vomit or by the stomach tube. There are so many individual variations in the amount of gastric juice secreted and in the relative proportion of hydrochloric acid present, that deductions drawn from an examination of the stomach contents must be applied with the greatest caution.

Increase in the amount of hydrochloric acid is indicative of no definite lesion, and the absence of free hydrochloric acid, though suggesting the possibility of cancer, is by no means diagnostic, as it may be absent in a variety of conditions. Save that its absence necessitates the consideration of the question

of cancer, it is doubtful if the symptom is of any special importance. Functional derangement of the digestive fluid may be detected by the delay of digestion. This delay is recognised by the retention by the stomach of portions of undigested food, and by observing the time taken to digest a test meal, and by the observation of the passage of a bismuth meal through the stomach by the X-rays.

Dilatation of the stomach is an evidence of a loss of the function of tonicity in the muscular wall, and can be detected by careful percussion, or by the presence of splashing when the stomach is shaken by succussion, or by tapping over the stomach. The extent of the dilatation can often be made out by distending the stomach with carbonic acid gas. The simplest method is to give the acid part of a seidlitz powder in solution first, followed by the alkaline. The evolution of the carbonic acid gas causes a visible swelling in the abdomen due to the distension of the stomach.

The use of the X-rays in the examination of the digestive tract has been of the greatest service. By giving a meal containing a large quantity of bismuth the movements of the food can be detected. Observation by this means has shed an unexpected light upon the position and shape of the normal stomach, and shows that the description usually given is quite wrong. In quite healthy people the stomach may be as low as the umbilicus. In fact so variable is the shape and position of the stomach in presumably healthy people that no certain standard is yet recognised. In consequence of this the recognition of abnormal conditions of the stomach by the X-rays

is mostly limited to cases of very great increase in size.

The retention of portions of food in the stomach for a considerable time affords evidence of the inefficiency of the peristaltic contractions to empty the stomach of its contents. Although dilatation is seen in its most characteristic form in emaciated people with pyloric stenosis, yet it may be of considerable extent where there is no obstruction; and there may be difficulty in deciding whether the dilatation is secondary to the pyloric stenosis. A long history of stomach trouble with pain, particularly if referred to the lower part of the epigastrium, suggests pyloric stenosis. In rare cases a history of vomiting blood, or of huge liquid vomits at intervals, is also suggestive of pyloric stenosis. Apart from pyloric stenosis dilatation of the stomach is a very common condition, and may be present when there is no symptom pointing to digestive insufficiency. At other times dilatation may be found associated with all kinds of symptoms.

The cause of dilatation is, as I have said, a lack of tonicity in the muscular wall. It is impossible to account for its appearance, and although it may be spoken of as a symptom of "atonic dyspepsia" yet it may be present with no dyspepsia.

85. Structural Symptoms.—Apart from the evidences of dilatation which have been alluded to, the symptoms produced by changes in the organ itself are limited to the detection of tumours in the stomach wall. In the early stages they are impossible to recognise, partly because of the manner in which they occur as a somewhat diffuse thickening of the

stomach wall, and partly because of the unyielding contraction of the overlying muscles. It is only when the tumour is in the anterior wall, or has increased to a considerable size, that it can be detected. By that time the patient's condition, if the tumour is malignant, will have suggested the serious nature of the complaint.

Constriction of the stomach, however, may arise as a result of contraction of gastric ulcers (hour-glass contraction). The detection of this condition is a matter of some difficulty, but it may be suspected when in washing out the stomach a portion of the fluid poured in cannot be drawn off.

86. The Diagnosis of Stomach Affections.—From the foregoing discussion it will be seen that in the vast majority of stomach affections there are few signs that may be considered distinctive of any one complaint. When a diagnosis can at once be made in any given case, the patient has been suffering for a considerable time. As the general practitioner is usually consulted long before a definite physical sign, as a tumour, blood-vomit, or dilatation, is apparent, and as the symptoms of ailments from the simplest to the most serious are at first identical, it is necessary to adopt other methods in order to arrive at a diagnosis, such as watching the progress of the affection, its response to treatment, and the general condition of the patient.

As diets are so varied, the personal predilection of the doctor may lead him to assume that the patient's trouble at first is due to some dietetic error. In this he may be right, and it is always best in any given case to start the observation by ordering the

patient the simplest and most easily digested form of food. My own practice, in all doubtful cases, is to attend to decayed and deficient teeth, to prescribe a diet in which the food is given in small amounts, the solids dry so as to ensure efficient and thorough mastication, and the fluid mostly in the form of milk, also small in quantity. With people who have to follow their daily work (which is the case with the majority of patients who consult the general practitioner), the food should be taken every two hours. When at work this may be limited to a dry crust, to be thoroughly and slowly masticated. At other times meat or fish with dry bread or toast may be given, if the patient is able to digest it with comfort. The quantity must be regulated at all times by the suffering of the patient. By this simple process the majority of cases of indigestion due to error in diet will be relieved. Speedy relief after such a change of diet, or from some simple remedy, must not be taken as an evidence that the stomach is free from any serious lesion—all that has been done has been to remove the stimulus that was adequate to produce the reflex symptom (pain, hyperalgesia). This is a point on which it is necessary to insist, for many cases of severe stomach disease may be thus temporarily relieved. In such cases the history must be inquired into, and the presence of other symptoms sought for. Persistence of suffering and of hyperalgesia of the epigastric skin and muscle, with contracted recti, are signs usually indicative of ulceration. When these dietetic changes are followed by no improvement, rest in bed is the next step, and the patient may have to lie many months before improve-

ment sets in. When there is dilatation, washing out the stomach and examination of the contents is of use.

The appearance of symptoms of indigestion in persons over the age of forty years, with wasting, should at once arouse the suspicion of malignant disease. In all cases the appearance of the patient should be studied, and in case of blanching the question of hæmorrhage should be carefully inquired into.

The possibility of gall-stone disease should always be borne in mind in chronic forms of indigestion. In severe suffering the temperament of the patient may aggravate the symptoms, for the reaction of a slight stomach lesion in a neurotic subject may cause widespread sensory phenomena.

87. Pain in Gastric Ulcer.—As gastric ulcer can frequently be definitely localised, the comparison of the site of the ulcer with the site of pain sheds a light upon the mechanism of visceral pain, and illustrates the practical value of the method of examination where the reflex symptoms are carefully observed. I have watched patients with gastric ulcer continuously for a great number of years, and have had the opportunity of verifying the diagnosis post-mortem, or at operation, in a good number. The result of these observations has been to show that, though the actual site of the ulcer had no direct relation to the place where the pain was felt, there was a fairly definite relation explicable by the nervous connection of the parts. In many cases the patient can localise the pain with great definiteness in some limited region, and the skin and deeper tissues may there be hyperalgesic. In such cases I have found that when the ulcer was situated near the

cardiac end of the stomach the site of pain and hyperalgesia was in the upper part of the epigastrium, when the ulcer was in the middle of the stomach the site of pain and hyperalgesia was in the mid-epigastrium, and when the ulcer was at the pylorus the pain was felt at the lowest portion of the epigastrium.

To illustrate, not only the justification of this view, but, more important, its practical utility, I will cite some typical instances. I was called into consultation to see a young woman twenty hours after perforation of the stomach had taken place. The patient had suffered for many months from pain after food. She located the site of this pain with great certainty in the upper part of the epigastrium, over the xiphisternum. I reasoned from this that the perforated ulcer would be near the cardiac end of the stomach. The incision opening the abdominal cavity was, therefore, made as far to the left as possible. On opening the abdomen there was found a large quantity of fluid, and a considerable quantity of flaky lymph covered most of the exposed organs. The stomach was carefully searched, and we found it rather firmly adherent at the cardiac end to the posterior wall of the abdomen. We inspected the whole of the stomach except the adherent part, and there can be no doubt that the adhesions surrounded the ulcer. We resolved not to break down these adhesions, as it would have been impossible to drag this portion of the organ sufficiently far out to enable us to stitch it. The abdomen was very efficiently flushed, the wound stitched up, and the patient made a good recovery.

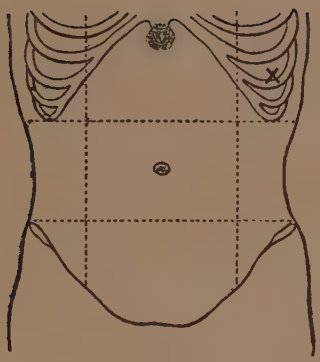

FIG. 14.

The shaded area shows site of pain, × corresponds to the position of the ulcer in the stomach as found at the post-mortem examination.

Another patient I saw in consultation suffered from peritonitis, resulting from perforation of a gastric ulcer. She was a servant girl, twenty years of age. For three years she had suffered at varying times from severe indigestion, and, a year previous to my examination of her, she had vomited a quantity of blood. The pain from which she suffered was situated in the upper part of the

epigastrium, just over the xiphoid cartilage (in the shaded area of Fig. 14), and was felt through to the back. When admitted to the hospital, the abdomen was hard and tense, the pulse very soft and 160 per minute. The abdomen was extremely tender to the touch; but on closer examination this tenderness was found to be purely cutaneous, the hyperæsthesia extending beyond the limits of the abdomen—over the lower part of the thorax and down over the thighs. In a few days the hyperæsthesia disappeared except in a diffuse, ill-defined area about the epigastrium; the greatest tenderness always being over the upper part of the epigastrium. The patient sunk and died. At the post-mortem examination there was found much matting of the stomach, bowels, and liver in the upper part of the abdomen by recent soft peritonitic adhesions. The stomach was found perforated by a large ulcer near the cardiac end, its position *in situ* being nearly as far out as the mid-axillary line (indicated by ×, Fig. 14). There were two other superficial ulcers in the immediate neighbourhood, but they were nearer the œsophageal opening than the perforation.

A girl, aged fourteen years, who had had pain after food for many months, referred the situation of the pain with great precision to a spot in the middle of the epigastric region (Fig. 15). She was suddenly seized with collapse and severe pain over the upper part of the abdomen. There could be no doubt that it was a case of perforation of the stomach. Within eight hours we opened the abdomen, and as I had noted the situation of the pain previous to the rupture, I suggested that the ulcer

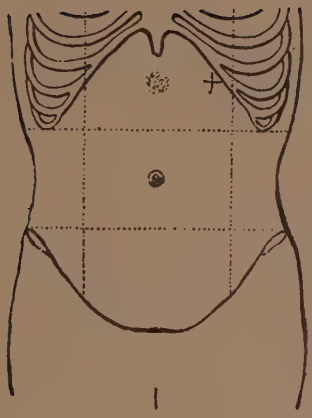

FIG. 15.

The shaded area shows the site of pain, and the + the position of the gastric ulcer as found at the operation.

would probably be found in the middle of the stomach. The incision was therefore made well to the left of the middle line. The perforation was readily met with in the middle of the stomach on the lesser curvature, in a position corresponding to the + in Fig. 15. It was stitched up, and the patient made an excellent recovery.

A female, aged thirty-two years, for ten years had frequently vomited large quantities of blood, and suffered from severe pain in the epigastrium. The pain was always felt with the greatest intensity at the lower part of the epigastrium, corresponding to the area shaded in Fig. 16. From this region the pain would frequently strike round the left side, and be felt severely over the sixth and seventh dorsal vertebræ. The painful area in the epigastrium was often extremely sensitive to the touch, and the cutaneous hyperæsthesia sometimes extended as a broad band round the left side. The last note I made about the patient was on 1st April, 1897, to the effect that the patient "vomited a large quantity of blood yesterday. The pain is felt very severely midway between the xiphoid sternum and the umbilicus, striking round towards the left side"; and then follows a diagram noting the area, as marked in Fig. 16.

In treating this patient, at an early date, a blister the size of a florin had been applied over the painful area in the epigastrium. So much relief was obtained when the cutaneous surface was raw, that savin ointment was used to keep the wound from healing, until all symptoms of pain had disappeared. During the last five years of her life (she died of phthisis) the patient had been in the habit, from time to time, of applying the blister herself whenever there was a recurrence of the pain. At the post-mortem examination the effects of a recent blister were still evident, as a superficial erosion, occupying the lower part of the epigastrium, corresponding exactly with the area shaded in Fig. 16.

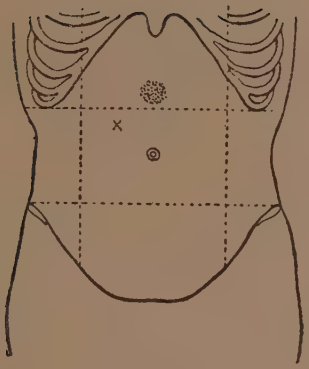

FIG. 16.

The shaded area shows the site of pain, × the site occupied by the ulcer at the pyloric orifice of the stomach as found at the post-mortem examination.

The patient died suddenly on 7th July. At the post-mortem examination held next day, an ulcer, 1 in. in diameter, with slightly thickened edges, was found situated partly in the stomach and partly in the pylorus. I requested my colleague, Dr. Brown, to note exactly what position the ulcer occupied in relation to the external body wall, and he, carefully noting the situation, indicated an area corresponding to × in Fig. 16.

Another case had been under my care for ten years for repeated attacks of epigastric pain. The pain in this case was very constant, unless during three pregnancies when she was quite free. She consulted an eminent surgeon who wrote to me stating that the patient had an ulcer in the middle of the stomach and on the posterior wall, and he recommended an operation for her relief. I re-examined the patient and made the following note in my diary : " That, inasmuch as the pain is situated at the lowest part of the epigastric region, and as there is also here a limited area of tenderness of the skin, the ulcer should be found at the pyloric orifice." This latter view was verified at the operation subsequently performed.

A patient whom I had attended for twelve years with mitral stenosis, and who died in 1907, aged thirty-six, suffered severely from gastric ulcer in 1899, so that she had to be kept in bed for two months, and be fed with the greatest care. The pain gradually abated, but kept recurring at intervals. It was always referred to the epigastrium, but radiated widely. Thus I made this note on May 13th, 1903 : " Has severe pain starting at the shaded area (as in Fig. 16) and passes round to the left side. There is no tenderness of the skin or muscles, and no vomiting. Stomach resonance as low as the umbilicus." She died in February, 1907, from her heart affection, and at the post-mortem examination an ulcer was found at the pyloric end of the stomach —at some distance from the epigastrium. The relative positions of the site of pain and of the ulcer were the same as shown in Fig. 16.

CHAPTER XV.

THE LIVER, GALL-BLADDER AND DUCTS.

88. *Nerve Supply.*
89. *Reflex Symptoms in Gall-stone Disease.*
90. *Gastric Symptoms in Gall-stone Disease.*
91. *The Result of Reflex Symptoms.*
92. *Functional Symptoms in Gall-stone Disease.*
93. *Structural Symptoms in Gall-stone Disease.*
94. *Fever in Gall-stone Disease.*
95. *Nature of Reflex Symptoms in Affections of the Liver.*
96. *Functional Symptoms in Affections of the Liver.*
97. *Structural Symptoms in Affections of the Liver.*

88. Nerve Supply.—The symptoms associated with the liver, gall-bladder, and ducts, in many cases resemble those of the stomach so closely that there is often a difficulty in differentiating the one from the other. This will be understood when it is borne in mind that developmentally the liver and its appendages are an outgrowth of the digestive tube immediately below the stomach. The region in the cord from which the nerve supply passes is at, and immediately below, the region of the stomach supply, from the seventh to the ninth thoracic ; so that with severe stimulation the irritable focus in the cord invades the nerve supply of the stomach. As in stomach

affections, the reflex phenomena appear in the epigastrium, but in gall-bladder affections the hyperalgesia is most common on the right side, and the upper part of the right rectus muscle becomes contracted. The symptoms also tend to spread to the right side and lower down in the abdominal wall. In addition to the thoracic nerve supply the liver and gall-bladder and ducts are also supplied by the phrenic nerve (third, fourth and fifth cervical) and by the vagus.

89. Reflex Symptoms in Gall-stone Disease.—The reflex symptoms in affections of the liver itself are often not very distinctive, while those of the gall-bladder and ducts are frequently violent and very characteristic. This difference is due to the fact that the former is a glandular structure, while the latter contain non-striped muscular fibres which, we have seen, may provoke the most violent sensory phenomena.

The pain in gall-stone disease varies much in severity. It may begin with a sense of uneasiness in the epigastrium, or over the lower ribs on the right side. A small area of cutaneous or muscular hyperalgesia may be detected somewhere in the region in which the pain is felt, and also in the upper portion of the right rectus. This muscle may be more or less contracted. These symptoms may be slight and variable, and continue for months or years, or the patient may be seized suddenly with violent pain, with or without these preliminary symptoms. The pain in the majority of cases of gall-stone colic is situated in the middle line, about the lower part of the epigastrium. It may come on gradually and remain for an indefinite period, sometimes varying

FIG. 17.

The shaded area shows the region of cutaneous hyperalgesia after an attack of gall-stone colic. The + is the position of a tender point in many cases in gall-stone disease, and is over the place where a twig of the ninth thoracic nerve passes out of the rectus abdominis muscle.

slightly in intensity. From this place it tends to spread to the right side, and may be felt with great severity below the edges of the ribs. Sometimes it may extend round to the back, and be felt most severely over the ninth and tenth ribs. In rare cases the pain may only be felt in the back.

The pain, intermitting slightly, may remain for many hours, unless relieved by a sedative. Frequently after the subsidence of the pain the skin and muscles

of the upper part of the right side of the abdomen become very tender to touch, and the muscles hard and contracted. In Fig. 17 the area of cutaneous hyperalgesia is shown in the patient in whom I first discovered the presence of hyperalgesia in 1891.

In a great many cases, after the subsidence of the attack, the hyperalgesia may persist for several weeks, and, during this period, severe attacks of pain are very liable to be provoked, so that the patient is scarcely able to move about.

In a small percentage of cases pain, sometimes of great severity, is felt on the top of the right shoulder, striking down the outside of the arm. It is very necessary to recognise the relationship between pain in this region and gall-stones. I have known patients in whom there was this pain in the shoulder and in the arm treated for years for "neuritis," and the passage of a gall-stone has been followed at once by relief. In many cases this shoulder pain is not very severe, and the patient may not refer to it. If, however, inquiry be made, the patients frequently declare they have had pain in the right shoulder, which they thought was "rheumatic." When this shoulder pain is severe and the chief complaint, if due to gall-stone disease a careful search will reveal evidences in the upper part of the abdomen, in the hyperalgesia of the skin, in the contraction of the muscles, and in the history of the patient which leave little doubt as to the cause of the shoulder pain.

90. Gastric Symptoms in Gall-stone Disease.—In persistent "dyspepsia" and heart-burn, the question of gall-stones should always be considered.

I have already referred to the association of pain on the ingestion of food into the stomach with gall-stone disease. One frequently sees patients with a history of "acute gastritis" of which the symptoms are described as attacks of severe pain in "the pit of the stomach," or "cramp of the stomach," followed by a period when ingestion of food causes pain. Such a history will, in the majority of cases, be found really to have been due to gall-stone colic, with the subsequent condition of hyperalgesia associated with an irritable focus in the cord.

Nausea and vomiting are frequent accompaniments of gall-stone colic, and their occurrence with the pain in the "pit of the stomach" might seem to confirm the conclusion that the case is one of "gastritis," or "cramp of the stomach."

91. The Result of Reflex Symptoms.—When we come to consider the effect of this hyperalgesia, contracted muscles and exalted reflexes, we get a picture that is often very misleading. After the attacks of severe pain have subsided the patient may be unable to breathe freely, each inspiration being checked, as it is in pleurisy, by spasm of the intercostal muscles, and severe pain may be felt over the lower ribs on the right side. Such symptoms are sometimes mistaken for pleurisy. If a careful examination be made, it can be demonstrated that there is an extensive field of hyperalgesia, extending up into the chest and implicating the intercostal muscles. The exercise of hyperalgesic muscles is always limited on account of their increased tone, and the tonic contraction tends to increase with their continued action. It is for this reason that patients

with gall-stone and persistent hyperalgesia of the abdominal muscles are comparatively at ease when at rest. On moving about there gradually comes on a feeling of pain and dragging round the abdomen, and the patient is unable to " stretch " himself freely. This is simply due to the fact that the exercise of the hyperalgesic muscles has increased their tonic contraction and their sensitiveness, so that their exercise is painful and the extent of their movement becomes greatly limited.

92. Functional Symptoms in Gall-stone Disease.—It is in only a small proportion of cases that jaundice is present in gall-stone disease. If the stone is situated in the common duct, or can cause pressure on the common duct, so as to obstruct the channel, then jaundice arises. When the jaundice is so slight that it is difficult to determine whether it may not be due to a sallow complexion, a careful inspection of the sclerotic may reveal a faint tinge. It may be necessary in cases of doubt to examine the urine or blood for minute traces of bile pigment.

93. Structural Symptoms in Gall-stone Disease.—It is only in very rare cases that gall-stones can be detected in the gall-bladder. It can only be done when the stones are so numerous as to cause a tumour, or when the stones cause the gall-bladder to become distended with fluid. This can only happen at a late stage in the disease, and when all the associated reflex phenomena have disappeared, for the presence of hyperalgesia means also the presence of a lively muscular reflex, which effectually prevents the hand reaching the gall-bladder. When

the abdominal muscles are lax the distended gall-bladder may be felt as a tumour, and, in rare instances, the stones have been palpated. The liver is sometimes said to "enlarge and become tender." As, however, the writers who describe this have not appreciated the association of this so-called "tender liver" with contracted muscles, this observation needs to be verified. For my part I have never been able to satisfy myself as to a slight liver enlargement when there is hyperalgesia and contracted muscles. The muscles are so tender on pressure and contract so firmly that it is impossible to palpate the liver; the percussion note also becomes altered with a contracted muscle.

94. Fever in Gall-stone Disease.—In the great majority of cases of gall-stone disease there is no fever, except, it may be, a slight rise at the time of an attack of colic. In some cases there is an associated inflammation of the gall-ducts, and, as a consequence, febrile attacks may occur of a very characteristic type. These are generally very sudden in their onset and in their subsidence. The patient begins to feel chilly and shivery, and when his temperature is taken it will be found to be considerably raised—101-104°. He may have rigors. In the course of one to three days the temperature returns to normal.

In more advanced stages of cholangitis the temperature may remain continuously above normal with frequent exacerbations. With the formation of pus the temperature usually remains continuously high.

In all obscure cases of intermittent temperature the possibility of gall-stones should be considered.

Except malaria, there is no disease which gives such characteristic febrile attacks. In many cases a slight jaundice can be detected.

95. Nature of Reflex Symptoms in Affections of the Liver.—I have dealt fully with the reflex symptoms in gall-stone disease, because in this complaint they are seen in their most striking form. In disease of the liver the same areas may be affected though the symptoms are less violent. As I have pointed out, it is doubtful if the affections of the parenchyma of an organ ever give rise to pain, unless the fibrous covering is affected or stretched. As a rule in liver affections there is little pain, unless this hyperalgesia of the external body wall and the tender structures are stimulated, as in exercise of the muscles, when pain will be felt in the muscles so exercised. This is well seen in cases of rapid increase in the size of the liver from heart failure, when the capsule is stretched, and when, if the patient moves about, there is considerable pain felt in the muscles over the liver, in front and round to the back. The enlargement of the liver due to heart failure offers an excellent opportunity for the study of the reflex symptoms of liver affections. These symptoms are seen most strikingly when the heart failure sets in with some rapidity, as in certain cases of paroxysmal tachycardia, especially when the tachycardia is due to auricular fibrillation, or where heart failure sets in as a consequence of the permanent establishment of auricular fibrillation. In certain cases this abnormal rhythm is suddenly developed, and in the course of a few hours the heart dilates and the liver becomes very considerably

enlarged. If the patient keeps at his work, feeling weak and breathless, severe pain is suffered from across the back and round in front over the liver. If he be examined a patch of cutaneous hyperalgesia may be found embracing a considerable portion of the upper part of the right side of the abdomen. The muscles below the ribs in front will be found hyperalgesic and contracted, and the erector spinæ muscles at the level of the eighth to twelfth ribs will also be found hyperalgesic. If the heart should suddenly return to the normal, the liver enlargement subsides in a few hours, and the hyperalgesia disappears. If, however, the abnormal rhythm persists, then with rest in bed the hyperalgesia gradually diminishes until one can palpate the liver through the abdominal wall, and even take tracings from the enlarged and pulsating liver.

In enlargement of the liver due to other causes, as hypertrophic cirrhosis, cancer, chronic and subacute abscess, the reflex symptoms are of the same nature but less acute. I have no experience of acute inflammatory affections of the liver, so cannot tell the nature of the symptoms present.

Severe and persistent vomiting may arise in liver affections. In the early stages of "catarrhal jaundice," before the jaundice appears, the patient may suffer from the most violent and persistent attacks of vomiting, and the cause may remain unsuspected till the jaundice appears.

96. Functional Symptoms in Affections of the Liver.—Jaundice is, of course, the most striking, and needs no further description. In all cases of sallow or dirty grey complexion, the liver should be

carefully examined. When chronic liver affections produce jaundice, or alter the complexion, there is generally present also a considerable degree of wasting. This wasting, with an enlarged liver and a faint jaundice tinge, is very suggestive of malignancy. In some cases of chronic heart failure there may be wasting, enlarged liver, jaundice, slight or severe, which simulate malignancy so closely that a mistaken diagnosis is not uncommon. If the heart be examined the evidences of heart disease are always so marked that no difficulty should be met in recognising the real nature of the liver trouble.

97. Structural Symptoms in Affections of the Liver.—Normally the upper margin of the liver dullness corresponds to a transverse line drawn at the level of the junction of the sternum and the xiphi-sternum. The lower edge corresponds in the nipple line to the right costal margin.

Organic symptoms may be recognised as an enlargement of the organ, or a diminution of its size. When there is much muscular hyperalgesia it is often difficult to define the limits of the organ. In the absence of this, little difficulty is found in detecting the extent of the liver enlargement. This is better done by palpation than by percussion, as a distended bowel may communicate a resonant note, particularly with enlargement of the left lobe. In enlargement of the organ from heart failure the organ can sometimes be felt to pulsate. This is perceived by putting the left hand behind and pressing forward the liver, while the right hand is laid over the liver, which will be found to heave gently with each cardiac contraction. The extent to which the

liver may enlarge is very great, and its lower margin may extend as low as the brim of the pelvis.

The surface of the enlarged liver may be nodular, as in cancer and cirrhosis. In the great majority of cases the enlargement of the liver is downwards, but in hydatids of the liver, the cyst being on the upper margin, the liver dullness may extend upwards to the third rib. Percussion gives rise to the characteristic thrill due to vibration set up in the fluid contents of the cyst.

The liver may be pushed down by abnormal conditions in the chest, as in emphysema or pleural effusions, or it may be displaced downwards on account of laxity of its ligaments and of the abdominal muscles (hepatoptosis).

It may be dragged up into the chest, as in the retraction that follows the absorption of a long-standing pleuritic effusion.

Diminution of the size of the liver may occur, as in atrophic cirrhosis, when it is the lower border that recedes.

CHAPTER XVI.

THE GREAT AND SMALL INTESTINE.

98. *Difficulties in Diagnosis.*
99. *Pain.*
100. *Appendicitis.*
101. *Affections about the Anus and Perineum.*
102. *Perineal Reflex.*
103. *Functional Symptoms.*
104. *Structural Symptoms.*

98. Difficulties in Diagnosis.—The difficulties in diagnosis of affections of the bowels are very great. The great length of the tube, with its coils confusedly mixed so that there is no safe guide to the locality of many portions, the continual shifting of each portion with the peristalsis of the gut, and our very imperfect knowledge of many of its functions, all combine to render diagnosis of bowel affections a matter of great uncertainty. There is a misconception, almost universal, as to the position and form of the great intestine, many pictures of this portion of the gut showing it as passing in swelling folds up the right side, across the upper part of the abdomen, and down the left side from the splenic flexure to the rectum. It is further stated

that the position of this gut can be made out by percussion. With the exception of the cæcum, which is more or less fixed in its place, and usually distended with gas, no part of the gut can be accurately mapped out. To begin with, it is doubtful if the descending colon is ever distended in the manner shown in the pictures. When empty of fæces it lies behind coils of small intestine, a contracted narrow tube. The study of the movements of the bowel after bismuth meals shows that the transverse colon varies extraordinarily in its position in different people. The ready distension of any portion of the small intestine renders attempts to differentiate the particular portion distended a matter of the greatest uncertainty.

A similar confusion exists in regard to the localisation of pain. The sensation of pain is frequently so diffuse that no clear indication of its exact site can be obtained in many cases. When severe pain arises from peristalsis the situation can often be localised with a certain amount of precision, but here the recollections of the patient are extremely unreliable. I have frequently been struck by the discrepancy between the patient's account of the position of the pain described from memory, and the actual position to which he refers the pain when asked to locate it while suffering from an attack of pain. For this reason the account given by the patient must be taken with great reserve.

To a certain extent the confusion also depends on the shifting of the site of pain. The cause of pain in the intestine is often due to strong peristalsis,

and in disease the peristalsis often does not appear at the site of the lesion, but at some distance above it, whence it gradually descends, and as the wave passes over coil after coil the position of the pain shifts likewise. Peristalsis may be stimulated below the disease, as, for instance, when the irritating secretion from an inflamed portion of the gut causes painful peristalsis as it is conveyed along the bowel.

On account of these and other reasons the diagnosis of bowel conditions is often extremely unsatisfactory, though the recognition of the difficulties should lead to a more careful scrutiny of the symptoms in each individual case. In the matter of pain, the patient should, if possible, be interrogated at the time he is suffering, and the position of the pain localised as he feels it. If this is impossible, then he should be asked to pay strict attention when it recurs to note the exact site of the onset and the subsequent radiation of the pain.

99. Pain.—I have already pointed out that the pain from peristalsis of the bowel is usually limited to the central areas of the body. In order to recognise the area in which the pain from any given portion of the bowel may arise, I have taken careful observations in cases of obstruction of the bowel, as one was frequently able to demonstrate the site of the lesion by operation or post-mortem examination. It is well known that the bowel below the obstruction ceases to contract and lies inert. On the other hand, the bowel above the point of obstruction is usually stimulated to violent peristalsis in the attempt to overcome the obstruction. In consequence of this violent peristalsis severe colic-like pains are set up.

Careful observation of the patient during an attack will reveal the fact that the pain starts high up in the abdomen, passes gradually lower and lower, till it reaches a climax at some definite part; then it ceases and does not descend lower. If when the pain stops this part be noted, the situation of the obstruction can be localised within certain limits. Unfortunately the limits are still wide; nevertheless, the information is extremely useful. If we take the usual divisions of the areas of the abdomen as in Fig. 13, page 116, it will be found that the peristalsis of the small intestine gives rise to pain limited to the umbilical region, never descending below that area. The cases in which I have specially studied the pains due to obstruction of the small intestine have been strangulated hernias, and I have had abundant opportunities in operating to verify the situation of the obstruction. This localisation of the pain in the umbilical region is supported by the experience acquired in the case of peristalsis, with the intestine exposed, already described. An attempt has been made to find out whether the localisation might not be more exact, by noting the level of the pain, but the sensation is evidently too diffuse to permit of such exact localisation. One would naturally expect to find a distinct relationship between the level of the pain and the position of the obstruction, but owing to this diffusion I failed to satisfy myself in any given case of the exact limits of the pain. The pain, when very severe just at the lowest limits, also extends widely across the abdomen at the same level. In many cases a diffuse area of hyperalgesia of the skin and muscles may be detected,

but it has been of such a vague character that I have not found it of much value as an aid in diagnosis.

In obstruction of the large intestine the pain due to the peristalsis descends to the hypogastric region (Fig. 13, page 116), and here certain limited deductions can be drawn from the level at which the pain stops. The cases I have studied have been patients with obstruction at the splenic flexure, or at the sigmoid flexure, and cases of hard masses of fæces retained in the rectum. In the obstruction at the splenic flexure the pain did not descend below the middle of the hypogastric area, while the pain due to peristalsis below the splenic flexure was felt about, and below, the middle of the hypogastric area. I have observed a number of cases with fæcal masses in the rectum, too large and hard for their expulsion by the anus, the pain being felt above the pubis. In these cases the situation of the pain and straining efforts seemed identical with the pains and straining during labour. This agrees with what has already been said about the situation of pain in diarrhœa and with distending enemata immediately before the expulsion of the fluid contents of the rectum.

In many people scybalous masses may lie in different parts of the bowel, and their presence may set up, after a time, violent peristalsis, in some cases accompanied by diarrhœa. Once the violent peristalsis begins it does not subside until the scybalæ are shifted. The people in whom I have observed this most frequently have been young women who have neglected their bowels. The pains are very severe, and the motions will often contain greyish hard

lumps. After the bowels have been voided a large area of hyperalgesia and muscular contraction over the abdominal wall is left. This tenderness and hardness and the history of colic-like pains give rise to many wrong diagnoses, the principal error being to attribute the symptoms to peritonitis.

100. Appendicitis.—The nature of the symptoms in appendicitis is illustrated in the following case :— Female, aged 36. For a couple of years the patient had suffered from violent attacks of abdominal pain. I never saw her during an attack, but the following was the condition found after a severe attack. The abdominal wall over the right iliac fossa was hard and rigid, due to the contraction of the muscles. When the skin was lightly pinched there was no increased tenderness but pressure on the rigid muscle was very painful. The right thigh was slightly bent upon the abdomen, and could be extended only with difficulty, owing to a tonic contraction of the psoas muscle. On walking a short distance the patient developed a stoop, due to the increased contraction of this muscle. When the erector spinæ muscles on both sides were lightly grasped in the lumbar region those of the right side were found very painful. There were frequent calls to micturition, the quantity passed at each time being small, and containing no abnormal constituents.

This description of the symptoms was confirmed by Mr. Caird, who operated on the patient. The following conditions were found at the operation :— When the abdominal cavity was opened nothing abnormal could be detected. The parietal peritoneum was perfectly healthy, and only healthy coils

of intestine were exposed to view. On separating these coils the appendix was found red and inflamed, adherent by soft red bands to the cæcum, and separated from the bladder by coils of uninflamed intestine. The appendix was removed, and the patient made a good recovery, though it was a couple of months before all the symptoms quite disappeared—the last symptom to go being the slight contraction of the psoas muscle, which became more contracted on walking a short distance.

Grouping the reflex phenomena in this case we recognise (1) A viscero-motor reflex in the muscular contraction of the transversalis abdominis, the oblique and psoas muscles; (2) a viscero-sensory reflex in the increased sensitiveness of the sensory nerves supplying the muscles over the right iliac fossa and the erector spinæ; and (3) an irritability of the bladder resulting in frequent micturition.

It is manifest from the condition found at the operation that these very definite symptoms could not have been caused by the implication of the structures in the inflammation which affected the appendix. If, on the other hand, we look into the origin of the nerves, motor and sensory, that supply these muscles and the sympathetic supplying the bladder, we find that they all arise from a limited area in or near the twelfth thoracic and first or second lumbar spinal segments. It becomes, then, a justifiable inference that the stimulus that produced these symptoms arose in the appendix, and that this stimulus was conveyed from the appendix by its sympathetic nerve supply to the spinal cord, and therefore that the appendix is supplied by a sympathetic nerve that

joins the cord at the segments mentioned. In Fig. 5, page 59, it is shown that the nerve to the bladder leaves the cord at two places—with the sympathetic nerves from the upper lumbar region, and with the visceral sacral nerves. In the case just cited the frequent micturition showed an increased sensitiveness of the bladder and so we can infer that the afferent fibres of the bladder reach the spinal cord at the upper lumbar region.

There are a few symptoms present in exceptional cases that need a passing notice. The nature of the attacks of " appendicular colic " is to me very obscure. In some cases the pains have been so distinctly referred to the umbilical region that I have considered the question whether the intestine above the inflamed appendix may not have been stimulated to violent peristalsis. That the colic in appendicitis may be due to violent peristalsis, at all events in some cases, seems possible from the following experience. A man aged 40 years had suffered for four years from violent attacks of colic and pain in the abdomen. He had seen several physicians and surgeons and ultimately a diagnosis of gall-stones was made, and he was operated upon. No gall-stones were found and no relief was obtained from the operation. I was asked to see him and I obtained, with difficulty, a clear notion of the site of his suffering and the spread of the pain. The pain started always just at the lower part of the epigastric region and descended slowly in the middle, increasing in severity to the lowest part of the umbilical region (space c, Fig. 13, p. 116). It might stop in this neighbourhood for some time, but did not descend

lower. From this account, it was reasoned that the pain was due to some hollow viscus, that as it persisted most severely in the central regions of the abdomen, gall-stone colic and the colic from a renal calculus could be excluded. The only hollow viscus that could cause pain in this region was the small intestine, and the radiation of the pain indicated that the peristalsis had started high up and stopped at the end of the small intestine. A painful peristalsis occurs only above the provoking cause, so that we could infer the cause would be found at the lower end of the small gut. Moreover, as in the great majority of cases the appendix is the provoking agent at this place, the probability was that the appendix was affected. Acting on this diagnosis an operation was performed. The small intestine was found deeply injected, especially at its lower extremity, and the appendix was found red, inflamed and adherent to the neighbouring structures, the adhesions obstructing the lumen of the lower part of the small intestine. The removal of the appendix and adhesions was followed by complete freedom from attacks of colic.

The appendix wall itself contains a muscle coat, and the contents are frequently confined by blocking of the passage, so it may perhaps be surmised that the colic arises from a spasm of the muscle coat. The reference of the pain to the middle line would be in accordance with the experience that peristalsis of any portion of the digestive tube causes pain in the middle line, and parts that have developed from the tube, as the gall-ducts and appendix, follow the same law.

I cannot satisfactorily account for the predominant symptoms from the appendix being so distinctly one-sided, seeing that it is developmentally a portion of the digestive tube. But it is interesting to note that, as in the case of the gall-bladder and ducts, and even of the heart, though the most severe pains may be situated across the middle line, the radiations and persistence of the phenomena are one-sided.

In extension of the inflammation in appendicitis other stuctures become involved, and these then give rise to the symptoms peculiar to themselves. When the inflammation affects the parietal peritoneum, and adhesions form with it, these symptoms will be found characteristic of peritoneal adhesions, as pain and tenderness over the part (*see* page 203). This fact may account for many of those aberrrant symptoms in appendicitis, as when it is situated in the pelvis and adherent to adjacent parts.

101. Affections about the Anus and Perineum.—A somewhat complicated series of symptoms arise in affections about the anus, in consequence of the nervous distribution passing from the autonomic to the cerebro-spinal system. As at the junction of other mucous and cutaneous surfaces the sensibility becomes profoundly modified, and there is a transition area where certain forms of cutaneous sensibility, such as pain, become more acute. This difference in sensibility is well seen in the case of piles, for so long as the pile does not encroach upon the tissues supplied by the cerebro-spinal nerves, no direct pain is felt, whereas pain of the most distressing character is felt when the pile encroaches on the mucous membrane supplied by the cerebro-spinal

sensory nerves. Pain, however, may be felt from an internal pile, and it is then referred to the back, over the upper part of the sacrum. I have seen much relief afforded from this pain by free hæmorrhage from an internal pile. This referred pain is sometimes extremely distressing in cases of ulceration within the rectum, especially after the bowels are moved. When the ulceration or fissure involves the sensitive marginal mucous membrane, the pain becomes at times agonising and prolonged, and is felt in an ill-defined area all around the anus and over the sacrum.

There is an intimate relationship between this region and the bladder, irritation at the anus producing frequent micturition, and sometimes spasm of the sphincter vesicæ. This reflex is well seen in women where the perineum has been torn at the birth of a child and afterwards stitched up, retention of urine being a frequent result. This reflex is probably limited to the skin of the perineum, as if care be taken in stitching the perineum not to include the skin in the stitches retention of urine is less likely to occur. The skin supply for this region is from the lower sacral nerves, and the nerve supply for the sphincter vesicæ is from the autonomic sacral nerves—that is, from the same region of the cord.

102. Perineal Reflex.—A curious connection exists between the perineum and the respiratory and other centres. This is seen particularly well in parturition, where, when the child's head presses on the perineum, the contraction of the uterus is sometimes greatly stimulated, and the mother is compelled to

"bear down" with uncontrollable energy. In patients lightly under chloroform the traction made by the forceps when the head reaches the perineum somewhat causes the patient to breathe in a deep and laboured fashion. Apart from its scientific interest this latter reflex has to be borne in mind in the administration of chloroform, as by the deep respiratory movements a greater amount of chloroform may be taken than is desirable.

103. Functional Symptoms.—Our knowledge of the symptoms arising directly from abnormal functions of the digestive tube is limited to the condition of the fæcal evacuations. These again must be studied in association with other phenomena, as pain, fever, distension of the abdomen. It is scarcely necessary to insist on the systematic examination of the fæces by the physician himself in all abdominal cases, and the patient should be instructed to observe for himself the character of the dejecta. The character of the normal stool is fairly constant, soft and moulded, yellowish-brown in the adult, pale whitish yellow in children and the milk-fed. The colour may vary with the food and with drugs. The absence of bile gives the characteristic pale drab-coloured stools. There may be an admixture of the stool with abnormal contents from the intestinal tract, as blood, mucus and pus. Blood from near the anus, as in piles, is usually unmixed with the fæces, either free or staining the fæcal mass. When its origin is higher up it becomes mixed with the food, and undergoing certain chemical changes, becomes black and "tarry" looking. The character of the mucus in the stools may give some idea as to its source; small

jelly-like masses accompany the diarrhœa from an inflamed swollen gut, shreds or membrane-like pieces are seen in affections of the colon and rectum. Other abnormal constituents may be present, as undigested food, gall-stones, intestinal sand.

The character of certain stools is fairly typical, as the diarrhœic, with hard scybalous masses, indicating that scybalæ are lodged in some part of the digestive tract, and setting up irritation; the "pea-soup" stools of typhoid fever and of pneumonia; the "rice water" stools of cholera; the "frothy stools" of infantile diarrhœa. The shape of the stool may be modified by its passing through a constricted passage near the anus. The recognition of obstruction, partial or complete, need not be insisted upon.

Indirectly there are signs of functional disturbance, as in the poor nutrition. Absorption of toxic products may interfere with the functions of other organs, particularly the heart, causing weakness, irritability, and pain. The skin of the armpits and of the abdomen may become of a dirty yellow colour from the same cause.

104. Structural Symptoms.—Symptoms due to changes in the bowels are very often difficult to make out, owing to the mobility of these organs, and the ease with which they can become distended with flatus. Except the cæcum and a small portion of the ascending colon and the rectum, there is no part in which changes can be with certainty located on account of shifting and distension of the intestinal coils. In addition to this, tumours and thickenings in any part of the abdomen so readily convey the tympanitic note from the bowel that percussion is

seldom of much use in detecting these when they are in the walls of the bowel. A further complication arises when small portions of the muscles of the abdominal wall become hard and contracted. Manifest changes in the bowels should always be considered with reference to the reflex phenomena already described.

CHAPTER XVII.

AFFECTIONS OF THE URINARY SYSTEM.

105. *Symptoms of Affections of the Kidney.*

106. *Symptoms of Affections of the Pelvis of the Kidney and Ureter.*

107. *Symptoms of Affections of the Bladder.*

105. Symptoms of Affections of the Kidney.—As in the affections of other glandular organs, there are practically no sensory symptoms evoked by disease of the kidney structure. Backache is sometimes put down as present in inflammation of the kidney, but considering how frequent backache is, some doubt may be entertained whether the kidney is the cause. For a great many years I have carefully inquired into the symptoms in all sorts of cases of albuminuria, acute and chronic, and I could find no evidence of pain of any form referable to the kidney trouble. All the symptoms of kidney disease (apart from alteration in the size of the organ) are found in the chemical examination of the urine, in the frequent micturition, or as the result of its impaired secretion on other organs and systems (vomiting, headache, convulsions, changes in the cardio-vascular system, dropsy).

Functional Symptoms.—In the routine examination of all cases inquiry should be made into the question whether the patient has to get up at night to pass urine, and, if such is the case, the urine should be examined for albumen or sugar. The presence of albumen should lead to the careful examination of other systems, particularly the heart and blood vessels, because it is the effect of the impaired kidney function on these that offers the best guide as to the importance of the albuminuria. It must be borne in mind that the presence of albumen is not in itself a matter of moment. It only indicates that albumen is passing through the secretory cells, and long experience has taught that when this happens there is an injury to these cells which prevents the elimination of other matters, which, being retained in the blood, have a deteriorating influence on other organs. It is for this reason that the significance of the kidney affection is often determined by the symptoms in other organs and tissues.

Structural Symptoms.—It is only when there is a considerable increase in the size of the kidney that we can detect its presence clinically with assurance. And even then the subject has to be of a somewhat spare habit. Normally we recognise a certain fullness under the lower ribs in either flank, which rather indicates its presence than gives a clue to its size. It is the relative greater fullness on one side that leads to the recognition of the increase in the size of this organ, and the absence of this fullness which leads to the suspicion of a displaced kidney. The nature of the enlargement in any given case is surmised from the presence of other symptoms, as

pus or tubercle bacilli in the urine, the cancerous cachexia, etc.

Movable Kidney.—The careful palpation of the abdominal cavity with the walls relaxed may reveal a movable kidney. It is often present without symptoms, but its presence may be associated with a good deal of vague, indefinite pain, dilatation of the stomach, and more or less nervous disturbance of a "neurasthenic" kind. Obscure attacks of vague pains, nausea and collapse have been ascribed to a movable kidney, and it is well to bear this in mind, for such attacks may be attributed to appendicitis or other intestinal lesion, or to renal colic.

106. Symptoms of Affections of the Pelvis of the Kidney and Ureter.—*Nerve Supply of the Ureter.*—The efferent nerves supplying the pelvis of the kidney and the ureter come from the inferior mesenteric, spermatic and hypogastric plexuses. The level at which these nerves leave the cord can be inferred from the study of the nerves implicated in the reflex phenomena in cases of renal calculus. From this study the nerves passing from the pelvis of the kidney and the ureter can be inferred to reach the spinal cord at the level of the lower thoracic and upper lumbar nerves. The distribution of the pain and the stimulation of the muscles to contraction, in the case of renal colic, give a clue to the cerebro-spinal nerves reflexly stimulated by the sympathetic nerves from the pelvis of the kidney and the ureter. The pain arising in the back above the crest of the ilium, passing round the front and slanting down

into the testicle, as in the shaded area of Fig. 18, page 185, traverses the fields of distribution of several spinal nerves from the eleventh thoracic to the second lumbar. In like manner the contraction of the muscles that accompany the pain gives a clue to the motor cerebro-spinal nerves that have been stimulated. In many cases contraction of the flat muscles over the iliac fossa (the external and internal obliques, and the transversalis abdominis) is produced, the lower portion of these muscles being supplied by the lower thoracic nerves. The contraction of the cremaster muscle, which is often such a distinct feature in cases of renal colic, implies a stimulation reaching the spinal cord at the level of the first and second lumbar nerves. It is interesting to note that a portion of the fibres of the cremaster are continuous with the internal oblique and both of these muscles contract in renal colic. The genital branch of the genito-crural nerve contains the motor nerve to the cremaster muscle, and also the sensory nerve to the tunica vaginalis, which latter becomes so hyperæsthetic in renal colic when the pain "shoots into the testicle," and it is manifest that it is to the peripheral distribution of this nerve that the pain is referred. It is to be remembered that the scrotal covering of the testicle is supplied by the sacral nerves, and the skin of the scrotum is never affected in renal colic.

Non-striped muscle enters into the structure of the pelvis of the kidney and of the ureter, and in consequence we have the reflex symptoms developed to a very marked and characteristic extent. While any circumstances that can arouse the severe

contraction of this muscle seem to provoke the pain and attendant phenomena, the presence of a renal calculus is, in the great majority of cases, the immediate cause. The following description, while referring to renal calculi, also applies to other causes, as pus or tuberculous ulceration, which may set up a painful contraction.

The position of the pain, its characteristic radiation, and the attendant muscular contraction, have been referred to. The place where the pain starts is of very great importance as giving an idea of the approximate site of the stone. It must be remembered that the gradual shifting of the pain from the back round to the front and down to the groin is not an indication that the stone itself is gradually being shifted and driven down the ureter. Nor must it be imagined that because the distribution of the pain has a vague resemblance to our notion of the position of the ureter that the pain is felt "along the ureter." The pain in its radiation is passing along some path in the spinal cord, and thereby affects the cord centres of the nerves distributed to the body wall in the area shaded in Fig. 18. Doubtless the peculiar path is directly associated with the nerve supply of the pelvis of the kidney and of the ureter, and as each part passes into peristalsis a definite portion of the spinal cord receives a corresponding stimulus, just as happens in the case of the peristalsis of the bowel.

Bearing this in mind, it will be seen that when the pain keeps recurring and starting from the same place the stone is stationary, and its presence

Fig. 18.

The shaded area shows the distribution of the cutaneous hyperalgesia after an attack of renal colic. The band traverses portions of the fields of distribution of the eleventh and twelfth thoracic nerves and of the first lumbar. The tunica vaginalis and the lower portion of the left abdominal muscles were also hyperalgesic.

stimulates a peristaltic contraction. Hence when we find repeated attacks starting at the back we may safely infer that the stone is lodged in or near the pelvis of the kidney. There is some doubt whether a stone in the kidney surrounded by glandular tissues and not protruding into the pelvis can ever arouse the pain characteristic of renal calculus, for it seems that contraction of muscle is the cause of the pain, and the calculus acts as a stimulus to the contraction.

The explanation of the locality of the pain is that the spinal centres of some fibres of the eleventh thoracic nerve which are distributed in the back are first stimulated, that as the peristaltic wave passes down it sends stimuli to other centres of the eleventh and twelfth nerves whose fibres are distributed in the area shaded in Fig. 18, and later to the genital branch of the genito-crural nerve which is distributed to the tunica vaginalis ; hence the pain which shoots into the testicle and the tenderness of the testicle, or rather of the tunica vaginalis, after an attack of renal colic.

In a number of cases the stone seems to stick on its way down the ureter, and the pains then start at a lower level. One may sometimes find a patient with a history of attacks of pain starting in the back, then after a time starting somewhere in the front of the abdomen ; then they have ceased, and the symptoms of irritation of the bladder have appeared for a period, followed by the expulsion of a calculus and complete relief.

I am disposed to think that in these cases the stone is lodged at the entrance of the ureter into the bladder. We know from observation on the bowel that violent peristalsis takes place above the point of obstruction, while the bowel below does not contract, and it seems that the same is true of the ureter. In these cases the pain passes down as low as the testicle, and this would imply, if my reasoning is right, that the peristalsis has extended to the lowest portion of the tube. It is not likely if the stone were lodged in the middle of the ureter, and completely blocking the lumen, that a peristalsis would be set

up in the part below. This is a point worth considering by those who have the opportunity of locating the stone by operation, and seems to be the explanation in the following case.

Male, aged 32, consulted me, with the following history. He had emigrated to America two years previously. For the first year he had enjoyed good health, but during the past year he had been in such constant suffering that his health was shattered, and he had returned to his native country, in the hope that the change might do him good. He was spare and thin, walked with a slight stoop, and his face was drawn and anxious. In conversation he was nervous and irritable, and I had the greatest difficulty in getting from him a distinct account of his complaint, as he had become extremely neurotic, and mixed his mental impressions and his digestive troubles with the description of pains in various parts of his body. With strict inquiry I found that his illness began with severe attacks of pain in his back, which he referred to the left lumbar region. For three months these attacks continued until he became weak and ill. After this the pain shifted, starting over the iliac fossa and striking into the testicle, and his testicle became tender, so that it hurt him to wear his breeches. In the past few months this pain had disappeared, and he was now suffering from great perineal pain, especially at the end of micturition. From the account given by the patient the salient points have been selected, leaving out the numerous other symptoms from which he suffered, and which he had mixed up in almost inextricable confusion, besides giving his own irrelevant

views as he went along. It was evident that the patient had had a renal calculus, which had shifted its position and was now in his bladder, and his long suffering had reacted on the nervous system, producing very characteristic neurotic or neurasthenic symptoms. I sounded his bladder and could find no stone, but assured him that there was a calculus in his bladder A few days after he again called to see me, a totally different man, erect and smiling, and held out to me, in the palm of his hand, a calculus, the size of a small bean, which he had passed the previous day. My reading of the symptoms was, a renal calculus, at first lodged in the pelvis of the kidney, then at the lower part of the ureter, and finally in the bladder. The suffering had weakened and exhausted the nervous system and produced other widespread phenomena. I have already drawn attention to the well-known fact that prolonged suffering tends to produce a hypersensitive nervous system, so that other affections, such as gastric flatulence, produce exaggerated symptoms.

The reflex symptoms resulting from a renal calculus may be much more extensive, and give rise to symptoms indicative of other lesions, as shown by the following case.

Renal Colic.—A man, aged 30, had suffered for a year from occasional attacks of renal colic, and one attack had been followed by hæmaturia. He was a very intelligent man, and I told him to note every particular during an attack. The following is a summary of his statement—the original statement being illustrated by the patient placing his hand

over the regions mentioned: The pain suddenly seizes him with great severity in the right lumbar region, then after a few minutes it strikes into the front of the abdomen over the iliac fossa. Then the belly becomes hard and rigid. The pain then strikes down into the internal part of the groin, the testicle is felt to be drawn up, and the pain then shoots into the testicle. The facts here described were corroborated by him in a few subsequent attacks, each attack invariably pursuing the same sequence. My notes made after an attack describe an indefinite area of cutaneous hyperalgesia over the iliac fossa, hardness and rigidity of the abdominal muscles over the right iliac fossa, with great tenderness on pressing over the muscles and on pressing the right testicle and the right erector spinæ muscles in the lumbar region. Here the symptoms pointed to a localised stimulation of the spinal cord at the origin of the sensory nerves supplying the skin over the right iliac region, the testicle and the abdominal and erector spinæ muscles, and at the origin of the motor nerves supplying these abdominal muscles and the cremaster muscle. These nerves issue from the spinal cord by the twelfth thoracic and first lumbar roots. The area stimulated in the cord, it will be observed, is not confined to one segment, but passes along a path which affects only a limited portion of several segments—a curious feature with which I have dealt in describing the radiation of pain.

In regard to the immediate cause of the symptoms, I reasoned that there was a calculus lodged somewhere about the pelvis of the kidney, and that its presence acted like a foreign body, sending a

wave of strong peristalsis down the ureter, the gradual passage of the peristalsis sending strong stimuli to a descending region of the spinal cord. The fact that the pain always started at the same place indicated that the stone remained fixed in its position, a view confirmed by the fact that there was never any evidence of the calculus having reached the bladder. The reasons I had for the assumption that the stone remained in the pelvis will be gathered as I develop my argument. An X-ray photograph failed to reveal the stone. Such being my opinion I sent the patient to Mr. Wright, who, agreeing with my diagnosis, operated in 1903, and found a small calculus about the size of a pin's head adherent to the apex of a calyx, opposite the junction of the middle and lower third of the kidney. This was removed, and the patient made a good recovery, and has remained quite free from all symptoms.

The nerve supply of the viscera and their connection with the cerebro-spinal nerves is fairly constant. Sometimes it would seem as if the centres in the cord were at a slightly different level, so that the sensory symptoms were referred to regions higher or lower than the usual level. Such is the interpretation I give for the high situation of the sensory symptoms in the following case.

Male, born 1864, consulted me in October, 1900, complaining of severe spasms of pain from which he had been suffering five days. He had had similar attacks twelve years before. He referred the pain with great definiteness to the area shaded in Fig. 19, this area corresponding to a region of deep cutaneous hyperalgesia—that

FIG. 19.

The shaded area corresponds to the site of pain and cutaneous hyperalgesia in a case of renal calculus after an attack of colic.

is to say, the skin here was very tender if gently raised and gently pinched, but showed no increased sensitivenesss to light scratching with a pin-head. This area of tenderness extended round to the spine. I was in doubt as to the cause of these attacks of pain. The onset and character of the sensation corresponded to an attack of renal colic, but I had never seen a case with the pain and tenderness so high. Under treatment (rest and opium) the attacks subsided. He again consulted me for a similar series of attacks in October, 1903. He had

had an occasional attack in the interval, but they were becoming more frequent. There was still present the characteristic area of deep cutaneous hyperalgesia, as in Fig. 19. During one of these attacks the pain suddenly passed into the left lumbar region, and then round to the front of the abdomen, to the groin and into the left testicle. At the same time he was conscious of the testicle being forcibly drawn up. When I examined him there was much tenderness on pressing the lumbar muscles and the left testicle. Under rest and opium the pain subsided, and two days later in voiding urine he passed a small calculus. There was complete freedom from pain until October, 1905, when he again had a few attacks of pain referred to the area shaded in Fig. 19. The pain passed downwards to the groin and testicle, and again he was conscious of the testicle being firmly drawn up. He rested in bed four hours, and upon micturating he passed another small calculus. He has remained free from any further attack.

107. Symptoms of Affections of the Bladder.—The bladder in its development is derived from two sources, the allantois and the cloaca. From the former there comes the upper division, and from the latter the fundus of the bladder (the trigone). The nerve supply of the bladder is likewise from two sources, from the upper lumbar region and from the sacral autonomic (second and third sacral) (*see* Fig. 5, page 59). As a result of this nerve supply the sensory symptoms are felt in two regions, in the hypogastric region, where the upper lumbar nerves are distributed, and in the perineum, and along the

penis, where the sacral nerves are distributed. The pain from an over-distended bladder, as in retention of the urine, is felt mainly above the pubis, and resembles in its situation and character the pain of uterine contraction or the pain of peristalsis of the lower end of the great gut. This pain is intermittent in character, and is due to the passage of the waves of contraction over the bladder. When there is much irritation of the bladder, as in acute inflammation of its mucous membrane, or in the presence of a stone, the contraction of the bladder at the end of micturition is sometimes very severe, and the pain is then felt both above the pubis and in the perineum, also along the penis. In many cases of stone, the pain from the perineum to the point of the penis is the most distinct, being felt most severely at the end of micturition, but severely also at other times, and patricularly if the patient is jolted. The viscero-motor-reflex is usually not well marked, but I have noted contraction of the lowest division of the recti in cases of stone in the bladder.

The act of micturition is a reflex that may be stimulated into activity in a great many ways. Normally there is a distinct relationship between the distension of the bladder and the act, filling of the bladder setting up reflexly the contraction of the muscular wall, which results in the expulsion of the urine. In the child the act of micturition is purely reflex, but with advancing age the individual acquires more or less voluntary control of the act of micturition.

In addition to the muscle wall of the bladder the abdominal muscles may assist by compressing the

bladder, and in expelling the last drops the perineal muscles (especially the levator ani and the accelerator urinæ) play an important part. The act of micturition in the infant, or the calls to micturate in the adult, may be so frequent as to raise the question of some abnormal accentuation of the stimulus. This may arise in a great many ways, as in the excessive quantity of urine secreted (in diabetes and certain forms of Bright's disease), the irritating nature of urine as in concentrated or very acid urine, the presence of abnormal ingredients as oxalates, pus, blood, calculi. The wall of the bladder may be inflamed and irritated, so that a small quantity of normal urine may serve as a stimulus. Stimuli from other organs and tissues affecting the spinal centres of the bladder may provoke frequent micturition, as in affections of the kidney, ureter, anus, and perineal region. Or there may be an irritable focus in the cord, due to lesion of some other viscus, which invades the bladder centre, so that impressions from the healthy bladder have an exaggerated effect and cause the frequent micturition seen in such cases as renal calculus, appendicitis, affections of the ovary and uterus, and piles. In these cases there will always be found some region of hyperalgesia in the external body wall characteristic of the particular organ at fault. A cause of frequent micturition often overlooked is over-distension of the bladder from some such obstruction as enlarged prostate in the male, or pregnancy or pelvic tumour in the female. Examination of the resonance above the pubes may reveal the dullness due to a distended bladder in the male, but when there is a pregnant

uterus, or other tumour, it may not be possible to recognise the distended bladder. The doctor, misled by an account of frequent micturition, may fail to detect the trouble, and very serious consequences may result from this being overlooked. In pregnancy, with retention of urine of this sort, the patient may die if relief is not speedily obtained.

Functional Symptoms. — Although the chief function of the bladder is to retain and expel the kidney secretions, it, like other mucous membranes, has a secretion of its own. The secretion is normally only perceptible in very delicate analysis of the urine. The contents of the bladder may irritate the mucous membrane, so that its secretion may be more abundant, and may become perceptible as a haze at the bottom of the glass when the urine has cooled and stood for some time. This mucous secretion may increase in quantity with the irritation or inflammation of the bladder wall, till the urine becomes thick and viscid, and even blood-stained, according to the degree of inflammation. Pus also may be secreted from the inflamed mucous membrane, or from an ulcer. These abnormalities, however, are to be detected by following the usual routine of urine examination, with which I do not propose to deal.

Structural Symptoms.—Changes of the organ can only be detected by its increase in size above the pubes, or by exploration with the finger in the rectum or vagina. In either case, when abnormalities are detected, additional evidence has to be sought by examination of the bladder by the catheter, by sounding, by X-rays, or by use of the cystoscope.

Chapter XVIII.

AFFECTIONS OF FEMALE PELVIC ORGANS.

108. *The Uterus.*

109. *The Ovaries.*

110. *The Vagina.*

I have been unable to satisfy myself as to the sensibility of some parts of the female pelvic organs. The uterus above the cervix is certainly insensitive to ordinary stimuli, for I have many times tested the interior, with my whole hand in the uterus, during and after labour, and in scraping out the contracted uterus. The pains during labour are undoubtedly referred, as I shall describe later. I cannot form any definite opinion of the sensibility of the cervix, or for that matter of the vagina. In regard to the cervix I have been able to pinch it and to prick it, with no sensation, but on the other hand great pain is often experienced when an attempt is made to dilate it. But whether this is a direct or a referred pain I could not decide. The patient is so conscious of the stimulation of the external genitals and to the discomfort in the sensitive parts, that her statements become affected by suggestion, and the reference is too confused to be of use. In the same way the extent of the supply of cerebro-spinal nerves to the vagina is not understood, nor could I

determine the limits by stimulation, for the sensory nerves are modified for special sensations. The tendency to exaggerated reflexes in most cases adds to the confusion, for such patients will say they experience a sensation before they are stimulated, and in their apprehension they anticipate or exaggerate the result. A further complication results from the difficulty in diagnosis, it being very rare to obtain a satisfactory proof of the nature of the ailment in cases showing what seemed the most typical evidence of referred symptoms. In the following brief description the subject is dealt with so far as reliable evidence could be obtained.

108. The Uterus.—The pain of uterine contraction is a distincly referred one, though this seems scarcely probable on superficial observation. In palpating the pregnant uterus during labour the onset of the contraction and the pain are simultaneous and evidently so distinctly related that it seems improbable that the pain is not a direct one, especially when the pain is so often described as being felt across the abdomen in the region where the uterus is felt contracting. But if the matter be inquired into more carefully it will be found that the pain is frequently not felt across the abdomen, but across the back at the level of the top of the sacrum. Here again the hasty observer has attributed the pain to the child's head "distending the cervix," or "pressing on the lumbar plexus"; but this pain is referred here before the cervix is distended, and also after the child is expelled, during the "after-pains," when the uterus can be found to contract, although the patulous cervix is untouched. This pain in the

back is found not only in labour at full term, but also during a miscarriage. The pain referred to the front of the belly, between the umbilicus and pubes, is also present when the uterus is not an abdominal organ but a pelvic one, as in miscarriage, after-pains, and other causes that induce uterine contraction. It is well seen in the severe spasms of pain that occasionally occur when some fluid from a vaginal douche escapes into the uterus and sets up uterine spasm.

In rare cases we may find the pains due to the contraction of the pregnant uterus referred to a distinctly lower level, and in one case the pains were all felt across the upper front portion of the thighs.

Very exact delimitation of the area of pain is not possible, but the region in which uterine pain may occur extends from the tenth thoracic to the third lumbar nerves, though in any individual case it is restricted to a limited portion of that distribution.

109. The Ovaries.—The nerve supply of the ovary is not exactly known, but, like the testicle, its development starts higher up in the abdomen than the position it occupies in adult life. The testicle has been shown to be developed between the tenth and twelfth dorsal vertebræ, and the nerve supply presumably comes from the same region. So far as I have been able to make out, the pain felt in ovarian trouble is referred to the lowest part of the abdomen of one side, and over the groin in the position in which the testicular pain is felt. The lowest portion of the abdominal muscles in this situation readily becomes hyperalgesic and contracted. This characteristic region of tenderness has often misled

observers into the belief that the pain evoked by pressure in this region was due to a "tender ovary," a statement with some truth in it, but not in the sense intended, for the ovary itself in such cases is not affected by the pressure, the pain of the pressure arising from the stimulation of the hyperalgesic skin or muscle.

Beyond an indefinite patch of hyperalgesia of the skin in the region of the groin, extending sometimes for a variable distance down the thigh, I have not been able to make out much that is reliable in regard to the hyperalgesic area of ovarian disease. It is in these cases we often find such widespread areas that it is doubtful how much is due to the actual ovarian lesion.

Associated with all forms of pelvic trouble are a number of other reflexes. Thus the breasts frequently become tender, especially at the menstrual period. A cough is sometimes spoken of as being "uterine," or of ovarian origin, but I have not been able to convince myself of such a thing. Vomiting is a frequent reflex symptom, particularly in pregnancy, but here it is probably not of a reflex nature, but toxæmic. As I have already remarked, it is sometimes a pure reflex, as in the vomiting associated with the uterine pains. The effects of stimulation of the ovary have not led to a very definite result, partly because of the difficulty in doing this without stimulating the sensitive orifice (anal and vaginal). The ovary, like the testicle, is partly covered by germinal epithelium, and this may modify the sensitivity.

110. The Vagina.—The character of the pain in vaginal affections is so ill-defined that it is difficult

to say whether it is direct or referred. This is seen in the cases of urethral caruncle, where the pain may be of a very severe form and the localisation so vague that the detection of the cause is often a matter of some difficulty. It resembles in some respects the severe vague pain of an anal fissure. A powerful reflex contraction of the muscles that act as sphincter of the vagina, on certain conditions of irritation of the vaginal mucous membrane, may produce vaginismus.

CHAPTER XIX.

PERITONITIS AND PERITONEAL ADHESIONS.

111. *Insensitiveness of the Peritoneum.*
112. *Symptoms in Peritonitis.*
113. *Symptoms in Peritoneal Adhesions (Parietal).*
114. *Symptoms in Peritoneal Adhesions (Visceral).*

111. Insensitiveness of the Peritoneum.—I have already referred to the fact that the serous surface of the peritoneum is insensitive to any form of stimulation, but that the external layer of the parietal peritoneum is an extremely sensitive structure, stimulation of which produces the sensation of pain. It is commonly assumed that the peritoneum is an extremely sensitive structure, particularly when inflamed. I must say, however, that I have found no evidence of any increase in the sensibility of the inflamed serous surface when I have stimulated it directly, and I have done this repeatedly in patients free from any form of analgesia. To a certain extent the popular misconception of the sensibility of the peritoneum has arisen from the fact that no attention has been paid to the hyperalgesia of the structures of the external body wall, including the external layer of the parietal peritoneum. The result has been that

the evidence of peritonitis is almost invariably based on the pain and tenderness on pressure—evidence which, as I have endeavoured to demonstrate, is not due to peritonitis, but to the hyperalgesia of the structures of the external wall. That peritonitis may produce these symptoms is true, but it does so in the same way as the viscera produce them—*i.e.*, by reflex stimulation. The reason of the insensibility of the peritoneum is the same as that for the insensibility of the viscera, namely, that the nerve supply of the peritoneum arises from the sympathetic, with the exception of the external layer of the parietal peritoneum, where the nerve supply is from the cerebro-spinal nerves.

112. Symptoms in Peritonitis.—If we take a case of acute peritonitis a careful analysis of the symptoms reveals their true nature. Thus, in a case of ruptured gastric ulcer, where there was an extensive peritonitis limited to the upper part of the abdomen as shown by post-mortem examination, the patient lay on her back with the knees drawn up, partly to relax the abdominal muscles, and partly to avoid the pressure of the bed-clothes on the abdominal wall. She shrank at the first attempts to palpate the abdomen, and when the skin was tested it was found extremely hyperalgesic, the lightest touch producing the sensation of pain. The area over which this hyperalgesia extended had no definite relation to the extent of the peritoneal inflammation. Thus, for instance, in marking out the limits of the cutaneous hyperalgesia I found it extended for a few inches up over the chest and down over the thighs, the margin fading away indefinitely. The sensibility

of the muscles of the abdominal wall could not be tested on account of the hyperalgesia of the skin over them. They were, however, partially contracted, and the lightest palpation produced a rapid and strong reflex contraction.

In less extensive peritonitis these symptoms may be limited to a small portion of the abdominal wall, and when they are present it is impossible to distinguish them from the hyperalgesia and muscular contraction due to some visceral affection. The hyperalgesia following an attack of gall-stone colic, or due to a gastric ulcer, is almost invariably attributed to a "peritonitis," and this view is supposed to be proved when, during operation for gall-stones, a certain number of peritonitic adhesions are found. While peritonitis can produce hyperalgesia of the external body wall it should always be borne in mind that the viscera can also do this, and when hyperalgesia is found in gastric ulcer, after gall-stone, renal or bowel colic, the cause of the hyperalgesia is in all likelihood not peritonitis, but the presence of an irritable focus in the spinal cord, the outcome of the violent visceral stimulation.

113. Symptoms in Peritoneal Adhesions (Parietal).—I have broken down adhesions and found them insensitive, but when they are attached to the parietal peritoneum, dragging on them may produce severe pain. Ramström also describes the serous surface of the parietal peritoneum as insensitive, but that pulling on the adhesions attached to the parietal layer causes pain, thus agreeing with my own observations. I attribute this to the fact that the inflammation that resulted in the production of

the adhesions had extended to the peritoneal layer supplied by the cerebro-spinal sensory nerves. The difficulty in distinguishing between visceral pain and the pain due to the invasion of the external body wall is very great. In many visceral ailments the inflammatory affection extends and involves the sensitive structures of the abdominal wall, and with this extension a new train of symptoms arises which may lead to wrong inferences if these differences in the sensibility of the structures are not clearly kept in view. One can easily see how appendicitis may give rise to symptoms which are entirely confined to the reflex group, until the inflammation extends to the abdominal wall, when another series of symptoms may arise which are produced by a different mechanism, and are detected in the immediate region of the inflammation.

For the study of the symptoms of adhesions those formed after operation offer the best opportunity, inasmuch as their presence can be inferred and the operation has determined the condition of the viscera. Maylard says: "It is doubtful whether any opening of the general peritoneal cavity ever takes place without the subsequent formation of adhesions, for no tissues of the body seem so ready to exude a plastic cementing material, which glues almost at once any structure lying in contact with it." It is probably due to these adhesions that so much pain and tenderness is felt after some simple abdominal operation, even when the operation is purely exploratory, and no injury has been done to any viscus. The hyperalgesia in such cases is often muscular, and associated with a lively reflex of

the hyperalgesic muscles, so much so that their exercise, as in walking, may result in their shortening, from an increase of their tonic contraction, for a longer or shorter time. Small portions of these muscles may remain firmly contracted for long periods, and sometimes they so closely resemble a tumour in the abdomen that it is impossible to tell whether the hardness is a contracted muscle or not.

In a case of pyloric stenosis, in which gastro-enterostomy had been performed, muscle pain and tenderness persisted in the left rectus muscle. As the patient experienced no relief, she again consulted the surgeon who had performed the operation. He detected a small tumour in the abdomen, and insisted on an operation for its removal. I thought the tumour was a contraction of a portion of the fibres of the left rectus muscle at the upper portion of the second interseptal division. As, however, the surgeon was very confident of his opinion, and I was less sure of mine, the abdomen was opened. No tumour was detected, but there were numerous fine adhesions attached to the parietal peritoneum, stomach, and bowel. It was manifest that the apparent tumour had been entirely muscular, this contraction being in the nature of a reflex, for there was no extension of the inflammation from the adhesions to the muscles.

114. Symptoms in Peritoneal Adhesions (Visceral).—Adhesions limited to the visceral peritoneum may produce no symptoms, or they may produce very well-marked reflex contraction of the muscles, with more or less hyperalgesia of the skin or

muscles. This subject has not been worked out, and I have only been able to investigate it to a limited extent. It seems, however, one worthy of attention, and there are plenty of opportunities for its study, if careful notes of the condition be made before operation. For many years I applied it in the diagnosis of ovarian tumours to ascertain whether there were likely to be adhesions or not. Then I found that when the muscles of the belly-wall were not contracted and not tender there were no adhesions between the ovarian cyst and surrounding structures. When, however, there was much muscular contraction and hyperalgesia, adhesions were always found between the tumour and the surrounding organs. As, however, these observations were made and verified in only some twenty cases, they are manifestly insufficient for a definite statement, but I put forth this suggestion as a line of observation well worth consideration.

CHAPTER XX.

AFFECTIONS OF THE LUNGS AND PLEURA.

115. *Nature of the Subjective Sensations.*
116. *The Respiration.*
117. *Reflex Symptoms.*
118. *Functional Symptoms.*
119. *Structural Symptoms.*
120. *Affections of the Pleura.*
121. *Nature of the Pain in Pleurisy.*

115. Nature of the Subjective Sensations.—Owing to the constitution and the accessible situation of the organs, the physical signs of affections of the lungs are readily ascertained, and have been so well explored that I shall do little more than touch upon some of the reflex phenomena. Even though these phenomena can be so readily recognised, their mechanism is far from clear. The chief reflex which presides over the movements of respiration involves the employment of the muscles of the body-wall over such a large area that the symptoms often become very complicated. The subjective sensations of the patient arise also from such a number of causes that it is often impossible to understand how they are produced. As in other parenchymatous organs, no

form of stimulation of the lung tissue seems to be capable of producing sensation directly or reflexly. Below the epiglottis there is no sensation elicited from stimulating the air passages, though coughing is readily induced in certain regions. The lung itself is insensitive to stimulation when healthy (as is seen when an exploring needle penetrates the lungs) or when diseased. It is well known that the lung may be acutely inflamed, torn by an apoplexy, ulcerated and scooped out by a tuberculous process, and no sensation be felt by the patient. When pain arises in connection with affections of the lung, it is from the implication of the pleura in the disease process, or from the muscles of respiration becoming sore and tender from excessive exercise.

Although no pain arises in connection with lung affections, other sensations appear, as the sense of breathlessness, "air hunger," and a sense of suffocation. These sensations may be the occasion of acute distress, and provoke attempts at deep inspiration.

Dr. Haldane considers it "probable that 'air hunger' is always due to excitation of the respiratory centre in consequence of an abnormal condition of the blood. Nothing else is known to produce 'air-hunger.' The excitation may be due to (1) excess of CO_2. This is the normal excitant. The excess of CO_2 may be due to hindrance to entry or exit of air (asthma, bronchitis, etc.), or to hindered penetration of CO_2 from the blood to the alveolar air (pneumonic or dropsical conditions in the lung). A second cause is diminished alkalinity of the blood. This acts just like CO_2 on the centre. A typical example is the

hyperpnœa of diabetic coma (oxybutyric acid in the blood). If want of O_2 arises in the tissues from hindered absorption of O_2 by the lungs, from defective circulation (as in certain forms of heart failure) or other cause (Co_2 poisoning, poisoning by nitrites, or other substances, which disable the hæmoglobin, etc.), the blood also becomes less alkaline from lactic acid formation, or lactic acid is formed in the centre itself. The centre is thus stimulated, and hyperpnœa, as a secondary result of want of O_2, results. Want of O_2 does not seem to be a *direct* stimulus to the centre. It is only in a limited number of cases that pure O_2 can relieve dyspnœa."

116. The Respiration.—The movements of respiration consist in the contraction of certain muscles, increasing the size of the chest cavity, and producing the inspiratory act. The muscles employed in the act of respiration are the diaphragm, the external intercostal muscles, the levatores costarum, and serratus posticus superior. As these muscles in their contraction enlarge the cavity of the chest by raising the thorax and twisting the costal cartilages, and thus stretch the elastic tissue of the lungs, so when they cease to act the thorax falls by its own weight, assisted by the recoil of the costal cartilages and of the elastic tissues of the lungs. The thoracic cavity is thus reduced, and the air is expelled. It is possible that the internal intercostal muscles contract with each expiration. In both forced inspiration and expiration a large number of accessory muscles may take part in the respiratory movements.

Although the nerve supply of these muscles

involved in respiration come from widely separated portions of the cord, they are all under the dominance of one centre in the medulla oblongata—the respiratory centre—the *nœud vital* of Flourens, situated in close proximity to the nuclei of the vagus nerves.

The normal rate of respiration is from fourteen to sixteen per minute, when the body is at rest. Abnormalities are usually considered from the standpoint of increase in rate and violence of the act of respiration. There are, however, conditions of slow respiration, apart from mechanical obstruction, which are of some interest as they are associated with certain neurotic conditions, and the slow respiration produces a form of heart irregularity (sinus arrhythmia). However variable the rate, Dr. Haldane points out that the alveolar ventilation will be the same—the frequent breathing being shallow, and the slow breathing deep.

Although the physiology of respiration so clearly defines the method by which respiration is regulated, yet there is nothing so perplexing to explain as the influences that operate in producing abnormal forms of respiration. In any given case of increased frequency of respiration it is difficult or impossible to say whether the condition is the result of imperfect aeration or reflex stimulation. The presence of non-striped muscle fibres in the smaller bronchi leads to the surmise that these may become tonically contracted, and therefore prevent the entrance of air to the alveoli.

This action seems all the more probable when we reflect that asthma is so often the outcome of a

remote stimulation, as from the nasal cavity, and that muscular contraction is very susceptible to reflex stimulation. Dyspnœa of a very severe form may arise from peripheral stimulation, as is seen in pneumonia, or pulmonary apoplexy, when the breathing may be greatly increased in frequency and in violence. The alteration in the breathing is not the outcome of a diminution of the breathing space by the inflammatory exudation, or apoplexy, for the rate of breathing may suddenly return to the normal, with no diminution in the extent of the affection of the lung. Presumably here the increased respiration is the outcome of a reflex, but whether the stimulation played directly upon the respiratory centre, or whether it caused a reflex spasm of the bronchial muscles, we cannot tell. The dyspnœa arising from other sources is equally obscure. Dr. Haldane considers "the respiratory trouble in heart failure to be due (at least mainly) to the slowed circulation, and consequent imperfect aeration of the tissues. The deficiency of O_2 in the tissues will cause increased formation of lactic acid, and consequent diminished alkalinity of the blood, and consequent necessity for an abnormally great removal of CO_2 from the blood. The increased respirations may also materially assist the circulation by aspirating more venous blood towards the heart. The breathless healthy person is breathless from excess of CO_2 in the arterial blood. In heart disease there is no excess of CO_2, or deficiency of O_2 in the arterial blood, but this condition exists in the tissues owing to the slow circulation. Slight hyperpnœa will diminish the CO_2 in the arterial blood, and thus compensate

for excess of CO_2; but hyperpnœa cannot appreciably increase the oxygen in the arterial blood, and therefore cannot compensate for the want of O_2 in the tissues. The patient is therefore blue, although his breathing may not be noticeably increased. Exertion during any condition where the circulation (particularly in the coronary vessels) is defective, and cannot be increased in response to the increased need for blood, will lead to a fall of blood pressure, the heart being incapable of supplying enough blood to correspond to the increased flow (vaso-dilatation) in the working muscles. Fainting will thus be caused. The same effect is seen in CO_2 poisoning, where even a slight exertion produces fainting with absolute certainty, and may be fatal."

117. Reflex Symptoms.—*Cough.*—Coughing is essentially a reflex phenomenon, the centre for which is one of the numerous areas associated with the main respiratory one in the bulb. The stimulus is conveyed from the periphery by some branch of the vagus. The result of the stimulus is to cause first a deep inspiration, which is followed by a closure of the glottis, then by a sudden and powerful contraction of the muscles of expiration which forces the air through the resisting glottis. By this process the air drawn into the lungs by the preliminary inspiration is driven out with such force that all movable matter in the larger tubes is swept out. The area that most readily excites the cough reflex is the mucous membrane of the larynx, the nerve supply being from the superior laryngeal nerve, a branch of the vagus. The respiratory tract below the larynx and the lung tissue seem to be incapable of originating the

stimulus. The cough in affections of the lung arises only when the secretion has been carried by the contractions of the bronchial muscles, and by the cilia of the respiratory tract so far upward as to reach the sensitive region about the larynx. Thus it is that in pneumonia the cough may be only slight, and only provoked when the secretion has passed up the respiratory tube. In phthisis and abscess, and all cases where there is abundant expectoration, it is to be noted that the starting of a cough after a period of quiescence is followed by a persistence until the accumulated matter is expelled. The first cough is initiated by the gradual conveyance of the phlegm to the sensitive area, while afterwards the cough forcibly expels the contained matter, and so keeps up the irritation until there ceases to be forced out any more secretion. This sensitive region may be stimulated by the inhalation of cold air, and it seems to be the starting place of the spasm of uncontrollable coughing in whooping-cough. While this is probably the true explanation of the great majority of cases, coughing can also be excited by stimulation by other means. When a pleuritic effusion is aspirated, scratching the visceral pleura will often produce a cough, or irritation of the branches of the vagus that go to the stomach or ear may produce coughing. It is always well to exclude the possibility of irritation in the larynx, before assuming the presence of the more remote stimulation. A very curious cough reflex is sometimes present in persons who have an occasional extra-systole. This is usually due to the ventricle contracting prematurely before the auricle, and the individual may be conscious of this, and may

give at the same time a short cough—without the preliminary inspiration. In hysteria violent and persistent coughing may occur either from a trivial laryngeal irritation, or it may be in consequence of some other reflex irritation.

Sneezing.—A reflex of a somewhat similar nature to that of coughing arises from stimulation of the mucous membrane of the nose. It differs from a cough, inasmuch as there is no closure of the glottis, and the blast of air is sent through the nose as well as the mouth. It also differs from the act of coughing in always being a pure reflex. Coughing can be done voluntarily, but sneezing cannot. Sneezing can be inhibited by biting the upper lip, or pinching the edge of the nasal bones, even after the preliminary inspiration, and by a mental reaction, as when another person is observed to imitate the act.

Persistent attacks of sneezing are commonly associated with a swelling of the erectile tissue over the turbinate bones in the nose, and a free secretion from the mucous membrane of the nose and eyes.

118. Functional Symptoms.— *Aeration of the blood.*—Impaired function is seen in the degree of aeration of the blood, and in the character of the expectoration. Aeration of the blood is the main function of the lungs, and imperfect aeration is manifested in the production of the reflex phenomena (air-hunger, increased respiratory movements) and in the colour of the blood. The former of these symptoms has already been discussed; the latter is observed mainly in an abnormal colour of the external tissues, as in the lips, cheeks, or skin generally.

As with all other respiratory symptoms, the production of the signs of imperfectly aerated blood is obscure and complicated. The face may show a slight degree of duskiness, the redness be a little darker than that of health, or the redness of the lips a little deeper in cases, say, of mitral stenosis. Blueness of the lips may be due to imperfect aeration of the blood in the lungs, but it also may be due to slowing of the circulation. It is remarkable how much darker the venous blood becomes if the rate of flow through the capillaries be diminished. This is probably the cause of the cyanosis in congenital heart disease. In some cases there has been found a great increase in the number of red blood corpuscles, and a certain degree of duskiness is found in cases of polycythemia. Where there is a duskiness due to some permanent condition as polycythemia, or the cyanosis of congenital heart disease, exertion often increases the depth of the cyanosis.

In failing hearts, with embarrassment of the pulmonary circulation, a very considerable duskiness may be evident, as also in cases where there is obstruction to the entrance of air into the lungs. As the heart is exceedingly susceptible to oxygen, imperfect aeration of the blood has a very marked effect upon it, a diminished supply of oxygen acting speedily in stopping its action, and in the administration of chloroform this is one of the most important facts to be borne in mind.

Expectoration.—Expectoration is the product of perverted function, and may be due to a secretion of the respiratory tract or lungs. It may also come from regions outside the lungs, as when an abscess

or pleural effusion bursts into the lungs, or bronchi. It is the most frequent cause of cough, and coughing is due to the attempt to get rid of the secretion. The expectoration is conveyed in the first place by the contraction of the bronchial muscles, and by the cilia of the respiratory tract to the bronchial tubes, till an excitable part is reached, when coughing is induced, and the blast of air expels the accumulated secretion. The force exercised in compressing the chest helps to expel secretion accumulated in any part of the respiratory tract, or in the lungs and pleural cavity, so long as there is an exit.

The character of the expectoration indicates its source, a transparent and frothy expectoration coming from the upper air passage, while the more viscid comes from the lower, or from near the alveoli, as in the early stages of pneumonia, when it is usually stained more or less deeply with blood. A clear pink-stained mucus may result from a pulmonary apoplexy. A purulent sputum is due to a lesion of some standing. In bronchitis the sputum gradually changes from a mucous to a muco-purulent character. An abundant muco-purulent sputum is found in chronic bronchitis and old standing catarrhal pneumonia. With an excess of fever, the latter condition may resemble an attack of acute croupous pneumonia, but the abundant purulent secretion serves to indicate the nature of the illness. The secretion from phthisical cavities is also purulent. When large quantities of pus are expectorated, the source is a cavity in the lungs or pleura, or a subphrenic abscess, as a suppurating hydatid cyst of the liver.

The microscopic examination for bacilli and elastic fibres is fully detailed in text-books.

119. Structural Symptoms.—Structural symptoms are recognised by changes in the consistence of the lung tissue, in the invasion of the normal resonant area by structures of more solid consistence, changes in the shape of the chest wall, and the presence of accessory sounds or the modification of the normal respiratory sounds in auscultation. It is not my purpose to enter into the details of these changes, and I merely point out here that the existence of any abnormal state can only be ascertained by thorough knowledge of the normal condition of the lungs. The position of the lungs in relation to other organs, the modification of the signs of the lung in the different regions of the chest, should all be familiar through the systematic examination of a great number of healthy people. In all these observations, and more particularly in the examination of abnormal or diseased lungs, the recognition of the abnormal signs depends on the comparison of the signs in one individual with another, or in the comparison of the signs on opposite sides in the individual examined. As there are infinite gradations, it requires careful training to recognise many of the more delicate but none the less very important phenomena.

120. Affections of the Pleura.— *Insensitiveness of the Pleura.*—If the affection of the lung gives rise to no sensation of pain, the same cannot be said of the pleura, for the pains associated with pleurisy may be of the most violent kind. In consequence of this well-recognised fact, the pleura is supposed to be an extremely sensitive structure, though, as a matter of fact, it is as insensitive as the peritoneum

to ordinary stimulation. In a great number of cases, when the ribs have been resected, I have repeatedly explored the pleural cavity for any evidence of sensation, and I could employ no form of stimulation capable of producing pain. When I probed the visceral pleura, even to penetrating the lung, no sensation was produced; when I scraped the surface of the parietal pleura no sensation was produced, unless I pressed with some force, when a vague sensation was experienced, due probably to the pressure being exercised on the structures of the external body wall.

121. Nature of the Pain in Pleurisy.—From the result of such experience one is forced to consider carefully how the great pain felt in pleurisy is produced. Inquiry into the nerve supply of the pleura is fruitless, for there is practically no information about the matter in either anatomical or physiological text-books. Although I carried out a series of careful dissections of intercostal nerves to their finest branches, I could detect none entering the pleura. Whether there is a layer containing fine nerve endings outside the pleura similar to that described by Ramström lying outside the peritoneum, I do not know. A careful study of all the phenomena connected with a painful pleurisy reveals the mechanism by which it is produced, and gives some indication of its nerve supply. The most severe pain occurs in the movements of respiration, and is due to the painful contraction of the intercostal muscles. In the abdominal muscles the muscular hyperalgesia and tonic contraction can be demonstrated. It is not so easy to do this in the case of the intercostal muscles, but there is good reason for inferring that

FIG. 20.

Areas in which pain and hyperalgesia were present in a case of diaphragmatic pleurisy. The shaded area on the left shoulder is in the cutaneous distribution of the fourth cervical nerve, and is an evidence of the conduction of a stimulus from the diaphragm by the phrenic nerve, which leaves the spinal cord with the fourth cervical nerve. The phrenic nerve contains afferent fibres as well as efferent (motor), and it is in all probability by the former that the stimulus is conveyed to the centre of the fourth cervical nerve in the cord. The shaded area in the abdomen is in the region of distribution of the 8th and 9th thoracic nerves.

the viscero-motor reflex is as definite in pleuritis as in peritonitis. The muscles are often tender on pressure, and their contraction is not only painful but ends in a spasm which restrains the movements of the chest. The symptoms of pain and violent contraction are identical with those that occur when the muscle is hyperalgesic, apart from a pleurisy, as in the painful contraction of the intercostal muscles in " muscular rheumatism," and in those cases where the hyperalgesia extends into the chest wall from affections of other viscera, as in gall-stone disease (*see* page 159).

The mechanism of the pain can also be inferred from those cases in which it is felt at a distance from the inflamed pleura. When the diaphragmatic pleura is inflamed the pain may be felt in two regions very widely separated, namely, in the abdomen below the ribs and on the top of the shoulder. (Fig. 20.)

It not infrequently happens that the onset of pneumonia is accompanied by a severe pain in the abdomen, and the skin in the region where the pain is felt may be found extremely hyperalgesic. (Not infrequently, and particularly in the young, this pain misleads in the diagnosis, giving the impression that some abdominal viscus is at fault.) The area in which this hyperalgesia is found is within the peripheral distribution of the eighth and ninth thoracic nerves. I have no distinct proof that in such cases the pain and hyperalgesia are due to pleurisy, and not to the lung affection, except for the very common experience that the inflammation of the lung is painless, while inflammation of the pleura is usually

associated with pain, and the hyperalgesia may be detected in basal pleurisies without pneumonia. It is evident that there must be some correlation between the lesion and the area of hyperalgesia, and as no nerve from the region of the eighth or ninth thoracic nerves supplies the lungs, it is reasonable to conclude that the nerve supply from the inflamed pleura must be from this region. The pain felt in the shoulder is more instructive. It is, however, a somewhat rare phenomenon, but in the few cases I have seen in which there has been cutaneous hyperalgesia, the area could be marked out very distinctly, and was found to be within the distribution of the fourth cervical nerve. I have already dealt somewhat fully with the distribution of the phrenic nerve and its relation to the fourth and fifth cervical nerve. Its distribution being to the diaphragm, and not to the lungs, permits of the reasonable inference that the pain and hyperalgesia in the shoulder found associated with pneumonia are due to the pleurisy and not to the pneumonia.

From the consideration of these facts we can draw the inference that the pain in pleurisy is due to a reflex stimulation (viscero-sensory reflex), and that as there arises also a hyperalgesia of the intercostal muscles, their contraction is not only painful, but their continued exercise increases the violence and painfulness of their contraction. As happens in all muscles affected by a visceral stimulus (viscero-motor reflex), there is a great tendency with exercise for the muscle to be tonically contracted, and hence the constrained and limited movements of the chest wall present in pleurisy.

Chapter XXI.

Affections of the Circulatory System.

122. *Heart Failure.*

123. *The Nature of the Symptoms in Heart Failure.*

124. *Consciousness of the Heart's Action.*

125. *Breathlessness.*

126. *Viscero-sensory and Viscero-motor Reflexes.*

127. *The Viscero-sensory Reflexes in Dilatation of the Heart and Liver.*

128. *The Pain of Angina Pectoris is a Viscero-sensory Reflex.*

129. *Evidences of the Viscero-motor Reflex.*

130. *Organic Reflexes.*

131. *Summation of Stimuli the cause of Angina Pectoris.*

There is no system in the body whose function can be so well observed, and whose size and position can be better made out, than that of the circulatory system. As a consequence of this accessibility the circulatory apparatus has received a great deal of attention, and innumerable methods are employed in the investigation of its action. The value of many of these methods is unquestioned, but unfortunately the tendency has been to place undue reliance on

the results obtained by mere physical examination, and to neglect the more important indications to be derived from the reflex phenomena, chiefly expressed in the sensations felt by the patient.

122. Heart Failure.—In order to realise fully the meaning of cardiac symptoms, it is necessary to appreciate the mechanism of heart failure. By heart failure is meant the inability of the heart to maintain the circulation efficiently. The lack of efficiency may be made evident in extreme cases by such signs as orthopnœa, dropsy, unconsciousness. On the other hand, the failure of the heart to maintain an efficient circulation may be manifest long before these extreme symptoms appear. The first sign is a feeling of distress when the patient makes an effort. This may vary within very wide limits; for instance, turning over in bed may exhaust the heart's strength, or the patient may be unable to walk across the room, or up a flight of stairs, without some form of discomfort checking him. The exhaustion of the patient's strength in such circumstances is seen simply as a limitation of the heart's power to respond to effort. Each individual has become accustomed to what he can do with comfort, and he recognises his heart failure by not being able to exert himself with comfort to the extent he had formerly done. The symptoms produced in health by over-exertion are frequently identical with those produced by slight exertion when the heart has become weakened and where this slight exertion is more than can be done with comfort. It will thus be seen that the symptoms of heart failure are really recognised by a limitation

of the field of cardiac response, that is, the patient finds he is stopped, on a slight exertion, by the symptoms which, when in health, only stopped him after a prolonged, exhausting exertion.

This weakness of the heart can be expressed in another way, namely, the premature exhaustion of reserve force. It is because the heart possesses the power to lay up a reserve of force that it is able to respond to calls on its energy, so that it can accommodate itself to the varying activities of the body. When the body is at rest the heart not only overcomes the resistances opposed to its work with ease, employing only a portion of its power, but it is at the same time building up a store of energy ready to be liberated when the next call is made by the body for more work. After severe bodily labour the store of reserve forces become exhausted, and if the labour be persisted in, there arises a feeling of distress, which expresses the exhaustion of the heart's reserve force. It is this faculty of building up a sufficient reserve store that distinguishes a healthy heart from a weakened heart, and the first evidence of weakness is shown by a too speedy exhaustion of the reserve. This is made evident by distress being aroused when the individual undertakes some form of exertion he had been wont to do with ease—that is, by a limitation of the field of cardiac response.

It will thus be seen that the symptoms of heart failure in the first instance are personal, due to the patient's recognition of his limitations. The estimate is therefore a very variable one, and depends on each individual recognising his own limitations, and detecting when these limitations become narrowed.

Each individual obtains a fair estimate of his power of exertion, and this is his measure of health. A limitation of these powers in an intelligent patient calls attention to his condition. It will further be observed that the main symptoms of exhaustion of reserve force are the same when a healthy heart exhausts its store after a prolonged effort as when an enfeebled or diseased heart exhausts its limited store by a slight effort. These symptoms are in the main subjective and reflex, though certain changes may also be made out in the size of the heart and its rate and rhythm. It is, however, the subjective and reflex symptoms that are of the greatest importance, whatever may be the nature of the functional disorder or structural lesion.

It will frequently be found that patients whose hearts show many forms of functional and structural abnormalities (valvular murmurs, cardiac enlargement, irregular action) have such a store of reserve force that they can pursue laborious occupation with ease and comfort, and live to a good age. On the other hand, patients may show no physical sign of abnormality; the heart may be normal in size and in rate, and regular in rhythm, and the sounds be clear and free from murmur; but the reserve force be so small that the slightest exertion entails at once distressful symptoms of heart exhaustion, and the lives of these persons may be very precarious.

123. The Nature of the Symptoms in Heart Failure.—The value of symptoms thus depends upon the estimation of the amount of reserve force stored up in the heart muscle. An imperfect valvular apparatus is but an embarrassment to the heart muscle in

its work. We can detect that valvular imperfection by the presence of a murmur, but we can only draw a very limited conclusion as to its bearing on the heart's work. This is really obtained by considering the amount of reserve force, and the estimation of the reserve is made by observing how the patient's heart responds to effort. The same rule applies to other forms of circulatory changes, as affections of the myocardium and of the arterial system. When, therefore, we detect what we consider to be an abnormal sign, we must not draw our conclusions from that sign alone, but must consider how far its cause has proved an impediment to the heart's action, and this is done by estimating the amount of reserve force. In doing this a wise discretion must be exercised, for other factors may have precipitated the exhaustion. An individual may have an organic lesion, as a valvular defect, but in addition may have been subjected to a life that predisposes to exhaustion, as excessive labour, improper or insufficient food, mental anxiety, sleeplessness, infections, diseases of other organs; and such factors, rather than the mere valvular flaw, may be the actual cause of the exhaustion of the reserve force. Or the individual may have a sedentary occupation, wherein, owing to lack of judicious exercise, his reserve force has gradually diminished, until some unaccustomed but not excessive effort calls attention to the limited field of cardiac response.

Not only must a careful calculation be made of these accessory, and it may be all-important, factors, but there must be a recognition of the significance of the cardiac abnormalities or supposed abnor-

malities. I do not enter here on the points which indicate the nature and seriousness of such abnormalities, as, for instance, murmurs and heart irregularities, but I wish to insist upon the fact that the clinician should familiarise himself with such points. For instance, a young person may have a fainting attack, and when lying quietly in bed the pulse is found very irregular. This sign, which is a perfectly normal one, though rarely recognised as such, is not infrequently linked up with the fainting attack, with which, as a matter of fact, it has no connection, and the patient is subjected to unnecessary treatment and restriction, and he becomes alarmed by the idea that he has a weak or diseased heart. In advanced life another form of irregularity is of extreme frequency (the extra-systole), and the recognition of its presence, with some limitation of the field of cardiac response, often leads to the conclusion that the irregularity is in some way responsible for the other cardiac signs, and energetic but futile means are taken in the attempt to cure the irregularity. In the same way this morbid dread of the unknown leads to the idea that certain cardiac symptoms as pain, especially when dignified by the term of angina pectoris, is of very grave significance. If it be once realised that pain is as constant a symptom in affections of the heart as in other hollow muscular organs, and that the pain is as readily induced by adequate causes in the heart as in the stomach, a truer perception will be obtained of the symptoms of many obscure heart affections. I shall show later that pain is one of the expressions

of an exhausted heart muscle, and in order to appreciate its significance the conditions that have led up to the exhaustion of the heart muscle should be ascertained—a matter usually of no great difficulty—and these conditions will guide us to a safe conclusion.

If the idea be followed up that the earliest of heart symptoms are simply due to an exhaustion of the store of reserve force, it will be found that there is a great resemblance in the reflex symptoms among all forms of heart affections—functional and structural. The most important symptoms are confined mainly to the patient's sensations, and demand careful consideration. The mechanism by which they are produced is not at all times clear, and some of them are undoubtedly reflex; although I cannot give a full explanation of their production, I attempt here a brief description of the most important of the subjective symptoms and some of the phenomena associated with them.

124. Consciousness of the Heart's Action.—Under normal circumstances the movements of the heart and circulation are carried on without the individual being conscious of their action unless he voluntarily directs his attention to the subject. When the heart is over-stimulated it may contract with such force that the individual becomes conscious of its action. The stimulation may arise from a great many circumstances, as, for instance, from heat, either by a rise in the patient's temperature or from a hot bath. It may arise from nerve stimulation, as from mental excitement, or from some peripheral irritation in

the viscera. Its significance is greatest when it arises in consequence of exhaustion of the heart; coming on in consequence of bodily exertion, it is often the first sign of exhaustion of the reserve force. When it is thus produced, it forms a valuable sign for estimating the amount of reserve force present in the heart-muscle. It gives no indication of the conditions that have led to this exhaustion, for it may occur in a healthy heart after prolonged exertion, as well as in a diseased heart after a very slight exertion. Under these circumstances the heart's action is usually rapid as well as forcible, but in some cases there is not much increase in rate. The consciousness of the heart's action is often spoken of as palpitation. While it may not occasion much suffering, there are individuals of a neurotic type in whom this consciousness of the heart's action causes much distress. In these patients the heart may be quite healthy, and the palpitation is then the action of an undue excitability of the sympathetic nerve supply of the heart. As other portions of the nervous system are abnormally excitable the heart's action may cause considerable distress bodily and mentally. In patients with this neurotic temperament, where there is real heart trouble, as in mitral stenosis, palpitation on exertion may be so readily induced that it acts as a protection from over-exertion, because, in order to avoid its occurrence, the patient is perforce kept quiet.

The occurrence of palpitation should always lead to an examinaton of the nervous system as well as of the heart's condition.

Other sensations of the heart's abnormal action may be felt by the patient. A gentle fluttering may be felt within the chest during a period of irregular action. This may be brief and transient, or, as in certain cases of paroxysmal tachycardia, it may continue during an attack of many hours. Accompanying the latter condition there is often a feeling of exhaustion which leads the patient to rest, or to go about carefully and quietly. When the heart resumes its normal action the patient is at once conscious of a change and of a sense of relief. A more common sensation is that when the heart is felt to stand still, in what is called intermittent action of the heart. This sensation is usually felt in cases of extra-systole, which is so frequent in advanced life though occasionally present in the young. Here the ventricle contracts prematurely, and often before the auricle; the individual is not conscious of this premature beat or extra-systole which is followed by a long pause, and it is this pause which often alarms the patient. After the long pause the next beat is frequently big and powerful, and the patient may be conscious of the shock due to this. In nervous people this big beat often causes much mental anxiety.

Another curious reflex is sometimes met with in these extra-systoles, the patient giving a little gasp or cough when the extra-systole occurs.

125. Breathlessness.—Breathlessness is so frequently associated with affections of the heart that its occurrence under any circumstances necessitates a consideration of the heart's condition. It is so

common a sign of exhaustion of the reserve force that in an inquiry into a patient's cardiac symptoms the amount of exertion that can be undertaken before breathlessness occurs should be carefully inquired into. In many cases the breathlessness may occur independently of any bodily exertion, coming on when the patient is in bed, and persisting till the patient has to sit up and breathe in a laboured fashion (orthopnœa).

The mechanism by which breathlessness is brought about in heart affections is far from clear, and so many factors are concerned in respiration that any endeavour to explain its cause would lead to such vague and indeterminate speculation that, in the present state of our knowledge, little good would result. The great point is to observe the fact, to exclude other possible causes of breathlessness (as affections of the lungs, mechanical obstructions to the breathing, anæmia, and other blood affections), and then from a study of the cardiac conditions to determine the nature of the exhaustion that has been produced. This is seldom a matter of much difficulty when a sufficient experience of the various forms of heart disease has been acquired. The presence of a demonstrable lesion in the heart may be a guide, as shown by modification of the heart sounds, or changes in the size, rate and rhythm of the heart. In the absence of these the age of the patient may be suggestive—if old, degenerative changes in the myocardium; if young, the probability of some general infection, as tuberculosis; if middle-aged, the possibility of exhaustion of the reserve force from over-work, worry, bad

nourishment—in fact, the consideration of the factors that tend to exhaust the reserve force of the heart, breathlessness being often the first sign of such exhaustion.

Apart from breathlessness brought on by exertion there are some definite forms of breathlessness which are recognised as especially associated with heart affection. The best known of these is the Cheyne-Stokes respiration, where periods of apnœa alternate with periods of laboured breathing. Another characteristic form is that in which patients are seized in the night with attacks of breathlessness, and have to sit up and breathe in laboured fashion for periods of varying duration, from half-an-hour to several hours. This form of laboured breathing is sometimes spoken of as cardiac asthma, and its onset is often mistaken for the more common form of asthma. When asthma is found to occur in people of middle or advanced age for the first time, the possibility of its cardiac origin should always be borne in mind.

In many cases the patient breathes quietly though hurriedly, with no distress, and the respiratory condition may, in consequence, be overlooked, though the rate of respiration may be from twenty to thirty times per minute. With failing hearts (as in typhoid fever, in conditions in which elderly people are forced to lie in bed, or in valvular disease) this rate tends to increase, and on examination respiration is found to be shallow and limited to the upper portion of the chest. In such cases there will almost always be found evidence of stasis or œdema at the bases of the lungs. The first sign of this

condition, apart from the increased rapidity of the respiratory movement, is the detection of fine crepitations on deep inspiration heard over the base of the lung, on that side towards which the patient habitually lies. My usual method of detecting this is to ask the patient on which side he has lain, and then to ask him to sit up and to auscultate the base of the lung on the side on which he has lain. This is the first step in the physical examination of the patient. If done at a later stage the movements may have deepened the respiration, so that the crepitations have disappeared. One usually detects the fine crepitations on the first full and deep inspiration. In the early stages of pulmonary stasis, after this thorough ventilation of the bases of the lungs, the crepitations disappear. If measures are not taken to stop this tendency to œdema, or if in spite of all endeavours the œdema increases, the crepitations become more numerous and persistent, and the lung resonance may become impaired. In fatal cases the bases of the lungs become dull, there is an absence of the respiratory sounds, and post-mortem the lungs are found sodden and airless. In suitable cases there can be detected coincident with these lung symptoms evidences of the dilatation of the right heart, as epigastric pulsation due to the filling and emptying of the dilated right ventricle.

A sense of suffocation is an occasional symptom in heart affections. It may be the first sign of exhaustion of the reserve force, coming on when the patient exerts himself. It may suddenly seize a patient when he is lying in bed. Its mechanism is obscure. The sensation is usually referred to the upper part of the chest and throat.

126. Viscero-sensory and Viscero-motor Reflexes.—Under these terms I include such sensory phenomena as pain and hyperalgesia of the skin, muscles, mammary glands, and the contraction of the muscles, which gives rise to a sensation described "as if the breast-bone were breaking." After obtaining a full account of the patient's sensations and experiences, if careful inquiry be made in regard to a number of symptoms, as pain, constriction of the chest, soreness of the chest or arms, frequent micturition, increased flow of saliva, bad dreams, there will be found a number of phenomena which the patient does not include in his description, because his mind is occupied with the sensations which cause him suffering and discomfort. The accurate noting of these less obtrusive phenomena will often throw a flood of light on many an obscure process and reveal the mechanism by which the more obtrusive phenomena are produced.

In the physical examination careful testing for hyperalgesia should first be made. The skin of the left chest should be lightly pinched and compared with that of the right. The breasts should be lightly compressed and the resultant sensations compared. The tenderness to pressure of the pectoralis major where it forms the anterior wall of the left axilla should be tested. In the same way the skin of the neck and the sterno-mastoid should be tested. The upper edge of the trapezius muscle where it passes from the scapula to the neck should be lightly compressed along its whole border, and it will sometimes happen that certain areas will be found very tender. These are places where a small

nerve trunk is pressed upon. Special areas of tenderness may sometimes be found, as under the left breast, and over the second and third ribs in the nipple line. In one patient, where this latter tenderness was very marked, I found, at the post-mortem examination, on dissection, a small nerve trunk (the internal anterior thoracic nerve).

Angina pectoris affords an excellent illustration of the application of the principles I have endeavoured to enunciate, as the symptoms can be with certainty referred to the organ at fault, and because the complex of symptoms that are included in an attack of angina pectoris are capable of being analysed with great precision. This is, in a great measure, due to the peculiar distribution of the sensory nerves in whose peripheral distribution the characteristic phenomena are shown, and whose centres in the spinal cord and medulla are in close relationship to the centres of the autonomic nerves of the heart (sympathetic and vagus). The cases I cite demonstrate that the term "angina pectoris" includes a number of reflexes, and I give in detail the more conspicuous of these, namely, sensory reflexes, where the pain and hyperalgesia affect the chest, arm, head, and neck; motor reflexes, resulting in spasm of the intercostal muscles; secretory reflexes, shown by profuse secretion of saliva and urine. Some cases show other reflexes, as the respiratory, but the discussion of these would lead me beyond the object I had in writing this book.

Notwithstanding the numerous papers devoted to the consideration of angina pectoris, practically none have dealt adequately with the analysis of the

symptoms present during an attack. Angina pectoris is often surrounded by such tragic circumstances that it forms a suitable theme for disquisition, and on that account we too often get the lurid description of an impressionist artist instead of the plain, matter-of-fact description of an accurate observer. A careful sifting of all the details brings out the fact that the essential principles underlying the pains associated with affections of the heart differ in no way from those of any other hollow muscular organ. So terrifying is the attack to the patient that his perceptions of the details of his suffering are generally confused, so that often no clear account can be obtained from his description; but if he is intelligent and is asked to note particulars in subsequent attacks, he may be able to throw a very valuable light on the onset and character of the sensations he experiences. The observations made by the physician of patients during an attack also afford great help in this respect.

127. The Viscero-sensory Reflexes in Dilatation of the Heart and Liver.—Before dealing with the more characteristic attacks of heart pain which go by the name of angina pectoris, I wish first to draw attention to the very distinct sensory evidences that arise from the dilatation of the heart. These sensory symptoms are practically identical with those that arise in cases of distension of any other viscus, as the stomach, bladder or liver. To illustrate this I select cases where the dilatation of the heart occurs rapidly, and is followed by a rapid distension of the liver, such as we find in certain forms of paroxysmal tachycardia. In

certain of these cases the rhythm of the heart starts suddenly at some abnormal place in the auricle or ventricle, or at the fibres joining auricle and ventricle. The heart at once beats with great rapidity, but fails to maintain the circulation, and in consequence we have very rapidly developed great dilatation of the heart, fullness of the veins, enlargement of the liver, and dropsy. I have seen a number of these cases, and in two particularly I have observed some fifteen to twenty attacks, of which the following is a typical description.

The patient may be in good health and no abnormality be detected save, in some cases, the occurrence of an extra-systole. Suddenly the heart's rate becomes greatly accelerated, to 150 beats and more per minute. In a few hours the patient's face becomes dusky, the lips swollen and livid, and there appears great shortness of breath on exertion, marked increase in the size of the heart, distension and pulsation of the veins of the neck, and enlarge ment and pulsation of the liver. The jugular and liver pulsation are of the ventricular type. Pain and oppression may be felt over the chest. The skin and deeper tissues of the left chest become extremely tender on pressure in the area shaded in Fig. 21. If the left pectoralis major muscle be grasped where it forms the axillary fold it will be found extremely tender. The skin of the left side of the neck may also be tender, and if the left sterno-mastoid muscle and the left trapezius muscle, above the middle of the scapula, are lightly grasped they may be found exquisitely sensitive. The skin and muscles over the liver will also be found extremely sensitive to

FIG. 21.

The areas shaded in the neck, chest and upper part of the abdomen represent the distribution of cutaneous hyperalgesia in a patient suffering from acute dilatation of the heart and liver.

pressure, and the parts hyperalgesic extend over a much larger area than the enlarged liver. If the heart's rate revert to the normal the patient at once experiences great relief, and in a few hours all signs of the circulatory disturbances disappear. The hyperalgesia may last with diminishing severity for a few days. The tenderness of the skin and muscles in the regions described above may be found in patients during the early stages of dilatation of the heart from any cause, and is very common in heart failure

following the onset of auricular fibrillation. In some cases one can tell when improvement is taking place by noting the diminution of this tenderness.

There can be little doubt as to the mechanism by which the hyperalgesia of the tissues in the three regions is brought about. The relation of the dilatation of the heart and liver with these sensory phenomena is undoubtedly that of cause and effect. The tenderness to pressure of the tissues in the left chest is due to stimulation of the afferent sympathetic nerves by the dilated heart. These nerves stimulate the sensory centres of the third and fourth thoracic nerves in the spinal cord, so that a stimulus reaching them from their peripheral distribution gives rise to a painful impression. The tenderness of the left sterno-mastoid and trapezius muscle, and of the skin of the neck, is due to the afferent fibres of the " bulbar autonomic " system—that is the vagus, conveying a stimulus to the sensory roots of the second and third cervical nerves. The hyperalgesia of the tissues covering the liver is due to stimulation of the sensory centres in the spinal cord by the afferent sympathetic fibres from the engorged liver.

128. The Pain of Angina Pectoris is a Viscero-sensory Reflex.—The usual description given of the pain in angina pectoris is that it is felt in the heart and shoots into the arm, or that there are two pains, a local pain in the heart and a referred pain in the arm. If, however, a careful analysis be made of all the symptoms present, facts will be found that practically demonstrate that in angina pectoris there is but one kind of pain, and

FIG. 22.

The shaded area shows the distribution of the pain and cutaneous hyperalgesia in a typical case of angina pectoris. The roman numbers refer to the nerves implicated, viz., I, II, III and IV, thoracic nerves and VIII cervical nerve.

that its production is in accordance with the law I have attempted to establish, namely, that it is a viscero-sensory reflex. One is not able in every case to demonstrate the proofs of this hypothesis, but facts derived from suitable cases afford legitimate conclusions applicable to all cases. Shortly, these facts are, that the pain in the very gravest cases may be felt in regions distant from the heart; that

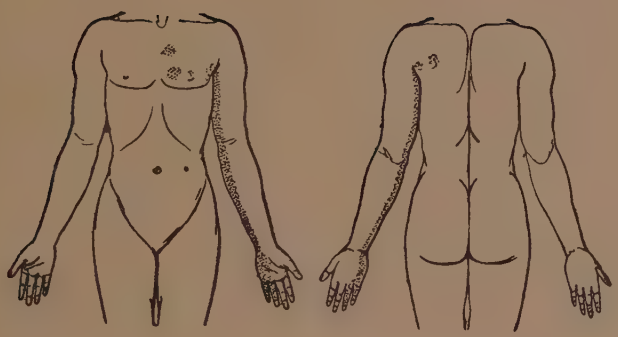

FIG. 23.

The shaded areas show the distribution of the eruption in a case of herpes zoster affecting the upper thoracic nerves.

this pain is identical in character with that felt over the heart; that the pain may originally start in parts distant from the heart, and gradually approach and settle over the heart; and, lastly, that the tissues of the external body wall, in the exact region in which the pain was felt, may be found extremely hyperalgesic after the pain has passed away. From this last fact it is inferred that, inasmuch as the seat

of pain corresponds to the region of hyperalgesia, therefore the pain was due to stimulation of the hyperalgesic nerves. To assume otherwise would be to ignore a principle that explains satisfactorily the sensation of pain wherever arising.

Another fact tends to support this view, namely that the eruption of herpes zoster affecting the arms may occupy a situation similar to that in which pain is felt in angina pectoris. Herpes zoster is due to an inflammation of the ganglia on the posterior roots of spinal nerves. Compare Figs. 22 and 23.

The following observations illustrate this point. They are examples chosen from a large number of cases that demonstrate the same feature. For the sake of brevity only those points bearing upon this argument are referred to.

Female, aged 30, suffering from stenosis of the aortic, mitral and tricuspid valves, was seized with a violent pain, referred to the outer part of the left side of the chest wall. The pain passed off, but a sense of soreness and smarting remained over the part in which the pain was felt. On examining her I found a portion of the skin of the chest extremely tender to touch, corresponding to the area shaded in Fig. 24.

A few days later she began to suffer from attacks of pain in the left breast and down the inside of the left arm, and on examination I found that the hyperalgesia had extended and occupied an area similar to that shaded in Fig. 25.

These attacks of pain became so severe on the slightest exertion that she was obliged to keep to her bed. She partially recovered from these attacks,

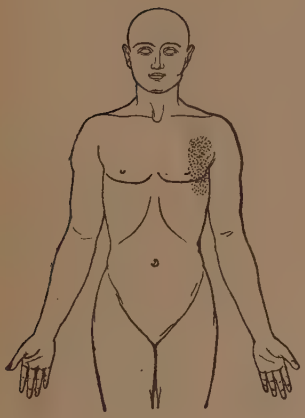

FIG. 24.

The shaded area shows the distribution of the cutaneous hyperalgesia after the first attack of angina pectoris (compare with Fig. 25).

FIG. 25.

After repeated attacks of angina pectoris the pain and hyperalgesia extended to the regions shaded here. Note the areas in the neck and inner side of right elbow (compare with Figs. 22 and 23).

but they recurred with increased severity. When suffering the most severe attacks the hyperalgesia embraced nearly the whole of the left chest and inside of the left arm, and also a portion of the right chest. The left sterno-mastoid muscle and trapezius also became very tender, and the patient would sometimes complain of pain on the inner surface of the right arm, at the elbow, where also I found a patch of cutaneous hyperalgesia. Two years and a half after the first attack of pain she was recovering from a series of violent attacks, when, on getting out of bed, she fell forward and died immediately.

The fact that in this case the attacks of pain were followed by a hyperalgesia of the skin in the region where the pain was felt, and the further fact that the pain started at a distance from the cardiac region, and was often felt most severely at a distance from the heart, proves that the cardiac pain in this case was a viscero-sensory reflex, and that the pain felt over the precordia was presumably of the same nature.

Female, aged 56, with high blood pressure, suffers from pain in the foot (gout), and has had several severe attacks of true angina pectoris, in which the pain is referred over the left chest and through to the shoulder. After the attack she passes a large quantity of clear urine, and the skin and deeper tissues of the left breast and the left sterno-mastoid and trapezius muscles become very tender on pressure. In one attack the pain was felt in a limited area over the second left interspace, and next morning I found the skin and deeper tissues at this place extremely tender to the slightest pressure.

In this instance, also, the hyperalgesia of the skin corresponded to the region where pain was felt, and is presumptive evidence in favour of the view that the pain as well as the hyperalgesia is the result of the viscero-sensory reflex.

Male, aged 42, consulted me on October 18th, 1905, complaining of pain in the left little finger and ulnar border of the left arm and forearm, coming on when he exerted himself at his work and on going up hill. For some months he suffered from a dull aching pain at the back over his shoulder blades. I found dilatation of the aorta, slight incompetence of the aortic valves, and slight enlargement of the heart (verified at the subsequent post-mortem examination). The blood pressure was 150 mm. Hg. During the following weeks the pain in the left arm increased in severity, gradually extended up the arm till it was felt in the axilla, and finally invaded the left chest. At first the pain was wont to start at the little finger and to pass rapidly up the arm, but latterly it seized him with such severity and suddenness that he could not tell where it began. It usually held him with the greatest severity either over the heart or in the inner surface of the left arm immediately above the internal condyle. I particularly asked him to note in his frequent attacks if there was a difference between the arm pain and the chest pain, and his reply was that there was no difference in the character of the pain, but, if anything, the arm pain was the worse. Sometimes the pain was very severe up the left side of the neck and behind the left ear. Under treatment he seemed to make considerable improvement. During January,

1906, these attacks recurred. During some of them the pain was so agonising that he felt he was dying, and wished to die. The pain was equally severe in chest and arm, and saliva sometimes dribbled from his mouth. On February 12th the least exertion was sufficient to induce a severe attack of pain; from three p.m. to seven p.m. he was scarcely free from pain, and ultimately became unconscious. When I saw him next day he was having another series of attacks. He was keeping his left arm very still, and helping himself to food entirely with his right hand. He told me he dare not move his left arm, as even the act of lifting the left hand to his mouth was sufficient to induce an attack. His pulse was extremely soft and weak. His blood pressure had fallen to 95 mm. Hg. During the following night he had another series of attacks, became unconscious and expired.

I omit many details in this case on purpose to emphasise the regions in which the pain was felt in a case of the most severe form of angina pectoris. It seems to me that no other explanation save that of the viscero-sensory reflex can satisfactorily account for the pains in this case, and to attempt to distinguish the chest pain as a heart pain and the pain in the arm as a referred pain would be arbitrary, illogical, and opposed to the evidence. The radiation of the pain from the hand to the chest was practically of the same nature as the more common radiation of the pain from the chest to the hand. The pain in the neck and behind the ear, on the same hypothesis, would be induced by the stimulus passing from the heart by the vagus,

a view that would also explain the increased flow of saliva during some of the attacks, points to which I shall afterwards revert.

It is interesting to note here that the movement of the left arm would induce an attack of angina pectoris. I have already pointed out that a stimulus from any source reaching an irritable focus in the cord will cause the characteristic pain to arise. In the next observation the stimulus reached the cord from the skin of the chest.

The two following observations of attacks of angina pectoris which I witnessed illustrate true heart pain of the most severe type at places remote from the heart.

Male, aged 14, suffering from adhesive mediastinitis, with enormous enlargement of the heart. The patient lay propped up in bed. As I was gently testing the sensibility of the skin outside and under the left nipple the patient was suddenly attacked with severe pain. He gave a great sob, and leant forward with his left upper arm across his chest, and his right hand pressing it gently. He rocked backwards and forwards with deep sobs, while tears streamed down his cheeks. His pulse became very soft and his face pale, with beads of perspiration on his forehead. In a few minutes the pain subsided and he lay back exhausted. Afterwards he said that, on my touching a certain spot, a pain shot from his chest to his arm, and during the whole time the awful pain remained in his arm, and he put his hand over the fleshy part of the upper arm. His doctor told me he had given up examining him by auscultation, because on a few occasions, on applying

the stethoscope, attacks similar to those I had witnessed were induced.

Female, aged 60, complained of pain of agonising severity limited to the ulnar border of the left forearm. Coming to see me one day she hurried to catch the train, and when she reached my consulting room she sat down. In a few minutes the pain seized her, and she took up her left arm and nursed it across her breast with evidences of great suffering. The pain subsided in a few moments. and she said she felt as if she would have died. The pain was felt nowhere but in the left forearm. Three months afterwards the patient died from heart failure. At the post-mortem examination there was found marked atheroma, calcification of the coronary arteries and extensive chronic fibrous myocarditis.

In this last case the pain was doubtless limited to the highest sensory nerve centre (first thoracic), whose fibres are associated with the sympathetic supply of the heart.

129. Evidences of the Viscero-motor Reflex.—So far I have dealt with the viscero-sensory reflex, and evidence no less striking can be found of the viscero-motor reflex among the group of symptoms included in the term "angina pectoris." Some would limit the term "angina pectoris" to that class of cases where, in addition to the pain, there is a sense of constriction in the chest, amounting at times to a sensation as if the chest were gripped in a vice, or as if the breast-bone would break. I am convinced that these sensations arise from spasm of the intercostal muscles, and correspond to the

hard contraction of the flat abdominal muscles in affections of the abdominal viscera. If one watches a case of what is called "muscular rheumatism" where the intercostal muscles are affected, and where these muscles are stimulated by the slightest movement to violent cramp-like contractions, one cannot but be struck by the resemblance to the description given of the "gripping" sensation experienced by patients suffering from certain affections of the heart. I have watched the attacks in such cases and could find no difference between them and those where the sense of constriction was the chief symptom in heart disease. The viscero-motor reflex may be present alone, or, as is more commonly the case, it may be associated with pain. The purely viscero-motor reflex is seen best in the elderly, where it may be considered as a symptom of one form of the terminal affections of the heart due to arterio-sclerosis or old age. I have found it a precursor of steadily advancing cardiac weakness, and although for a time considerable relief may be afforded, the changes in the heart are so advanced that, in the nature of things, only one end can be looked for. The three following observations illustrate these views.

Male, aged 82, with large tortuous arteries, was seized while walking with a sense of constriction across the chest that compelled him to stand still. These attacks became so frequent and so severe that he could scarcely walk fifty yards before he had to stop and lean against the wall. He described the sensation as one not of pain, but as if somebody gripped the upper part of the chest with a strong

hand. With rest and suitable treatment these attacks gradually disappeared. Three months later the heart suddenly became irregular (auricular fibrillation), dropsy set in, and he died seven weeks later from heart failure.

Male, aged 56, was seized with a spasm which held his chest as in a vice when he walked up a hill. There was no pain but the sense of constriction and a sense of suffocation produced such discomfort that he was forced to stand still. Within a few minutes the chest would feel free, but the sensation would at once recur if he attempted further effort of the same kind. Thus, in going to business, he had to go up a steep hill, but frequently found it impossible to do so, and then had to go downhill and reach his destination by another and less steep road.

Female, aged 78. Two years before her death she experienced attacks of breathlessness with a sensation of constriction across the chest. This feeling of tightness was so readily set up that she was obliged to stay in bed. The attacks disappeared, but recurred again shortly before her death. These latter attacks were accompanied by slight precordial pain. She became gradually weaker and died. At the post-mortem examination the coronary arteries were found markedly thickened, with calcareous patches in their walls.

The following experience illustrates the fact that the viscero-motor reflex is a symptom distinct from the pain.

Male, aged 48, consulted me on November 25th, 1905, for a pain he felt across the middle of his chest. He had felt a slight pain here for some

months on walking up a hill. He was a master-builder, and on this day, while watching his men at work, feeling cold, he began to help them to dig up some earth, to warm himself. He did this for a quarter of an hour with a good deal of energy. He then examined a few partially built houses, running up and down a great many steps. On his way home he became conscious of pain in his chest, and as it continued to increase in severity he called on me. I examined him carefully, and found a slight dilatation of the heart with an impure first sound. The blood pressure was 130 mm. Hg. On his way home the pain increased in severity, and after he reached home it became very violent. A colleague saw him and prescribed opium, which relieved him. When I saw him next morning he gave a graphic account of his sufferings. He said : " In the tram coming home the pain got worse, and after getting home it became so severe that I felt I was going to die. The pain spread from my chest down my left arm to my little finger. You asked me, when I saw you yesterday, if I felt any gripping sensation, and I did not know what you meant ; but, by George! I know now. When the pain was at its worst, I felt my chest suddenly seized as in a vice, and I rolled on the floor in agony. The pain and the gripping eased off for a time and then came on again. This continued till I got the opium. This morning I awoke all right, but at 10.30 that gripping sensation came on and held me tight for ten minutes. I dare not move for fear the awful pain should come on, and I felt every moment it was about to come, and I was in such terror of it that the sweat poured off me."

With rest and treatment these attacks grew less, till he only felt a slight pain when he over-exerted himself.

So far the symptoms I have dealt with have been mainly concerned with the reflexes connected with the sympathetic nerve supply. Equally instructive symptoms, though less frequent, can be shown to arise from stimulation of the vagus. At its centre in the medulla this nerve is in near relationship to the upper cervical nerves, and, it would seem, more particularly the sensory nerves supplying the sterno-mastoid and trapezius muscles. Not only may these muscles become extremely tender in various heart affections, but the pain from heart affections may be felt in the region of distribution of the cervical nerves as already noted. The following observations also show the same thing.

Male, aged 62, complained of great pain striking into his chest and behind his ears when walking. Thus, in going to his work, he allowed seven or eight minutes to walk to the station, but now it took him over half an hour, as he had to stop on account of the pain every fifty yards. After accurately noting the pain he described it as arising in the left breast, extending across to the right breast, seizing him in the neck, and extending up behind the ears, where it held him with great severity. In showing me the situation, he laid the fingers of both hands over the insertion of the sterno-mastoid muscle into the mastoid process. On one occasion the pain extended from the breasts to the armpits, and down the side of each arm to the elbow.

This patient dropped dead while at his work, and on post-mortem examination I found extreme calcareous degeneration of the coronary arteries.

130. Organic Reflexes.—Other very striking phenomena are sometimes met with during an attack of angina pectoris. During or after an attack an abundant flow of saliva and the secretion of large quantities of pale urine may occur; both symptoms I suggest are due to reflex stimulation of nuclei in the floor of the fourth ventricle. Possibly the polyuria may be of the same character as that in diabetes insipidus, which, as is well known, may be induced in animals by puncture of the floor of the fourth ventricle.

Male, aged 58, of gouty diathesis, complained of pain, induced by the slightest exertion, which arose in the left breast, passed up the armpit, and extended down the inner surface of the left arm to the little finger. During an attack an abundant flow of saliva took place into the left side of the mouth. These attacks became so frequent that he could only walk a very short distance without inducing an attack. He died while sitting at his desk, and at the post-mortem examination I found that the heart had ruptured, and the coronary artery was very atheromatous. Where the rupture had taken place the myocardium had nearly disappeared.

Male, aged 46, whose work entailed periods of great muscular exertion, complained of pain striking into the chest when walking up a hill. If he stopped as soon as he felt the pain coming on, it passed off, but if he persisted the pain increased to an agonising severity and radiated into both arms, but worse into the left, as far down as the little finger. At the same time the chest was gripped,

so that he was forced to straighten himself and to breathe deeply, and at the same time his mouth filled with saliva, and an aching pain was felt in the throat. A few minutes after each attack he had to pass urine, which was always abundant and very clear. These details I had from him after he had carefully noted a number of attacks.

131. Summation of Stimuli the Cause of Angina Pectoris.—The fundamental functions of the heart muscle correspond to those of other involuntary muscles that form the walls of hollow organs; these functions being modified to suit its special work. Like the other viscera the heart is insensitive when stimulated in a manner that provokes pain when applied to the tissues of the external body wall. I have pointed out that a long strong contraction of a hollow organ can produce pain, and that this is undoubtedly the cause of the severe pain associated with renal calculus, gall-stones, spasm of the bowel, and uterine contractions. Can the heart give rise to pain in a similar manner? On account of the modification of its functions, the heart cannot pass into a prolonged state of contraction. Immediately it contracts, the function of contractility is abolished and the muscle passes at once into a state of relaxation, and for this reason the pain cannot be produced by a "spasm of the heart." But I suggest that the heart muscle may produce pain when it is confronted with work greater than it can readily overcome, a condition which produces strong peristalsis and pain in other hollow viscera. But the pain in the heart arises by a slightly different mechanism. A skeletal muscle will contract in obedience to

stimulation of a sensory nerve going to the spinal centre of its nerve, if a stimulus of sufficient strength be applied. If the stimulus be too weak, no contraction follows, but if this weak stimulus be frequently and rapidly repeated, then the muscle contracts in accordance with the law of the summation of stimuli. I suggest that the heart muscle induces pain on the principle of summation of stimuli. If we minutely study our cases we shall find that the pain rarely arises at the first exposure of the heart to the effort that induces the pain. Sometimes effort has been undertaken a few minutes before the pain comes on, and in certain cases it may not come on for hours after the casual exertion has ceased.

From such observations we can infer that the heart muscle was exhausted by the exertion, and so great was the exhaustion of the reserve force that it was unable to regain its reserve on cessation of effort; thus the exhaustion persisted till it culminated in an attack of angina pectoris.

CHAPTER XXII.

ESTIMATION OF THE VALUE OF SYMPTOMS.

132. *The Relation of the Symptoms to the General State.*

133. *Remote Effects of the Lesion.*

134. *Relation of Symptoms arising from different Causes.*

135. *The Bearing of Symptoms on Prognosis.*

136. *The Bearing of Symptoms on Treatment.*

In this chapter I endeavour to sum up the general principles which have been applied in more detail in the earlier chapters. That the interpretation of symptoms should be imperfect can readily be recognised, for not only is the subject too vast to be dealt with in a few pages, but the knowledge to deal with it efficiently is lacking. I confine myself, therefore, to a few general principles that have been of service to me in my endeavours to estimate the value of symptoms in individual cases.

132. The Relation of the Symptoms to the General State.—Before a final opinion is formed of the value of any symptom, the physician must consider the patient as a whole, and the relation

of any abnormal sign to the general health. The patient's complaint may be of a trivial nature, and the examination of the different organs may reveal no abnormality; nevertheless the contemplation of the patient's whole economy may help one not to dismiss the symptoms too hastily because of their seeming triviality. Malignant disease of the stomach may cause the symptoms of a simple indigestion, but a slight loss in weight and a slight change in the patient's colour may ultimately be found to indicate the grave nature of the illness. The description of the patient's complaint may be given in such terms that the physician may fancy it is exaggerated and due to the patient being of a neurotic habit. This may be true, yet the complaint from which the patient suffers may have so undermined his strength that the neurotic habit has been induced by his prolonged suffering. It is necessary to state this because the presence of many reflex phenomena is apt to be pooh-poohed, because of the manifest hypersensitiveness of the patient's nervous system. There is no doubt that in people of a neurotic habit there is a greater tendency for reflex phenomena to be readily produced, yet the phenomena should not on that account be ignored, but should be utilised for the purpose of discovering the lesion if possible, and the neurotic tendency being duly discounted, their true value should be estimated. However widespread such symptoms as pain and hyperalgesia may be, there is always some irritation in the cord, induced, as a rule, by some trouble in the viscera or external body wall. This was well illustrated in the following case, which was under my observation for many

years. I attended the patient during several attacks of rheumatic fever from 1880 to 1884. She developed well-marked symptoms of aortic, mitral and tricuspid valvular disease, and was for years very short of breath occasionally, but had no pain or hyperalgesia. In 1895 she began to complain of pain, particularly after meals, referred to the lower part of the epigastric region, with a limited area of hyperalgesia. The pain became very severe, so that I came to the opinion that she had a gastric ulcer near the pyloric orifice. The hyperalgesia spread widely round to the left chest. She kept in bed for a few weeks, but began to go about her household duties before the pain and hyperalgesia had disappeared. She then began to have attacks of pain in the chest on exertion, slight at first, but gradually becoming more severe, until they resembled in every respect attacks of angina pectoris. Coincident with the pain, hyperalgesia appeared in the chest and arm. The distribution of this hyperalgesia, due manifestly to the heart lesion, coalesced with that due to the gastric ulcer, so that there was an extensive field of hyperalgesia embracing the left chest and abdomen, from the level of the second rib to below the umbilicus. At the patient's death there were found the lesions of the three valves mentioned, and an ulcer at the pyloric orifice. Anyone seeing the patient after the development of the extreme field of hyperalgesia might have attributed the whole condition to some such vague complaint as "neurasthenia," particularly if the nature of the cardiac lesions were not detected. I have seen another case with very severe attacks of angina pectoris and wide-

spread hyperalgesia where no cardiac abnormality could be detected. The extraordinary acuteness and extent of the sensory phenomena might have led to the surmise that there was only a neurasthenic condition, yet at the post-mortem examination the coronary artery was found almost impermeable, and the muscle of the heart greatly degenerated. The rule I make in these cases is to recognise the fact that, however exaggerated the reflex symptoms, and however neurotic the patient may be, the symptoms are nevertheless due to actual affection of some viscus, and a careful consideration of all the other features of the case will lead one to an approximately correct estimation of the value of the symptoms.

133. Remote Effects of the Lesion.—Not only may the continuance of a visceral lesion and prolongation of suffering lead to the exhaustion of the patient's nervous system (which is probably the reason for the ease with which the reflex phenomena are produced in many people), but the original ailment, in consequence of persistent suffering, may alter the whole mental balance of the patient. Previous to an illness he may be sensible, unselfish, and considerate of his relatives and dependents, but during illness he may become utterly selfish, wear out the patience of his children and dependents with his peevishness and want of consideration, in order that his own requirements and comforts may be satisfied. Patients in this condition are extremely difficult subjects for diagnosis, for it is to their interest to magnify their complaints, and it is difficult to estimate the value of their symptoms. This is particularly the case if one searches for

hyperalgesia of skin or muscle, for they readily complain of pain and tenderness. To discriminate the symptoms in such people the distribution of the sensory phenomena (pain and hyperalgesia) affords a very good guide. Thus if one tests for hyperalgesia of a heart affection, and the symptoms are found to extend up the chest and over the clavicle, one might reject the symptoms, for the skin over the clavicle as low as the second rib is supplied by the fourth cervical nerve, while below it is supplied by the second thoracic, so that the extension of the hyperalgesia from the second thoracic to the fourth cervical is not conceivable. So it is in other complaints; the peculiar distribution of the sensory phenomena in affections of any given organ being unknown to the patient, one can test his reliability by noting the distribution of his pain and hyperalgesia.

This method of discrimination is also to be used in distinguishing true visceral sensory phenomena in cases of suspected hysteria and malingering. If the symptoms are found to follow the distribution peculiar to one organ, even if the patient be evidently hysterical, then it may be concluded that there is an affection of the viscus, and it remains to make careful consideration of the other factors in the diagnosis in order to estimate what value the symptoms possess.

The intensification of reflex phenomena is particularly noticeable where the conditions of living have reduced the bodily strength, through worry, sleeplessness, or improper nourishment. I have been particularly struck, for instance, with the symptoms

of angina pectoris that may be induced in young people who have had a long and trying period of strain. Women who work hard for their living, or who look after household duties during the day, and have to attend an invalid parent or ailing child during the night, who are frequently disturbed in sleep, or who pass the greater part of the night in constant attendance, become gradually exhausted, and the struggle may go on until an attack of pain in the chest imperatively calls attention to the exhausted heart. In such people the attacks of angina pectoris may be extremely severe, and the hyperalgesia may be widespread, affecting both sides of the chest (the left breast particularly often becoming extremely tender), and, it may be, the neck, particularly the left sterno-mastoid and trapezius muscles.

In estimating the value of the symptoms in such cases the history of the patient's life gives an indication, and one can then recognise, with assurance, the condition of the heart that has provoked these manifestations.

Similar exaggerated symptoms, having a peculiar distribution, may arise should any other organ be affected; as in stomach affections, a slight indigestion may give rise to such symptoms as to make it difficult to tell whether some more serious condition, as gastric ulcer, may not be present.

In doubtful cases one feature when present may be taken as a rule to distinguish an affection of an organ from some general nervous manifestation, that is, the viscero-motor reflex. Unfortunately, this symptom is practically limited to

affections of the abdominal organs, and needs to be sought for with care, lest a too susceptible superficial reflex be started. But when detected it may be looked upon as demonstrating the presence of some visceral trouble.

134. Relation of Symptoms arising from different Causes.—When a patient presents himself one may be able, on physical examination, to detect some abnormal condition to which one can refer with certainty the cause of the patient's suffering. It may happen, however, that we detect an abnormality having no direct bearing upon the complaint of the patient, and in the absence of one having such a direct bearing, there is too often a tendency to refer the patient's complaint to the presence of the recognisable abnormality. There is no doubt that symptoms may be provoked by lesions remote from the place where they are experienced, as in referred pain, and there is no doubt that many other symptoms may be produced by lesions of remote organs, as in the widespread effects of kidney disease. But keeping all this in view, there is still need of a wise discretion in estimating the influence of lesions in which there is no recognisable connection with the symptoms. Thus epileptic attacks may be brought on by affections of the heart as in heart-block (Adams-Stokes syndrome), where the left ventricle becomes so slow in its action that the brain does not receive a sufficient supply of blood. In consequence of this anæmia the patient may faint or have an epileptic seizure. The well-recognised connection between a heart abnormality and an epileptic attack in this particular instance has led

to the assumption that, if a patient has epilepsy and at the same time has some affection of the heart such as irregular action, there is a connection between the two. Under such circumstances it is necessary to recognise the nature of the irregularity, and as it is now possible to demonstrate with precision the different forms of heart irregularity, the recognition of the particular form of irregular heart action at once permits of determining the probabilities of the heart being the cause of the epileptic attack in any given condition. Irregular action of the heart being so common, the occurrence of epilepsy is in the majority of cases due to an independent affection, and there is no casual relation necessarily present between the two conditions.

I have already referred to errors arising from attributing the cause of symptoms to some demonstrable structural affection which may be merely coincident or independent.

It is impossible to lay down rules applicable to all cases, and I write this in order that the subject should in every case receive consideration, since the recognition of the possibility of error may prevent the error being made.

135. The Bearing of Symptoms on Prognosis.—Of all branches of medicine there is none which has received so little real consideration as the matter of prognosis. The subject itself is one which has to be considered in nearly every case that comes under the notice of a medical man. Its importance is appreciated in all stages of life, and the just consideration of the meaning of symptoms is of cardinal importance in regard to the patient's future.

In addition to recognising the meaning of any abnormal sign or symptom, we should endeavour to acquire a knowledge of what bearing it has upon the future history of the patient. This knowledge can only be obtained by watching how patients exhibiting the abnormality withstand the storm and stress of life. This should be a special object of every general practitioner, for it is he who has the opportunity of watching individual cases over a long period of years, and of estimating the bearing of any abnormality on the patient's future life.

I am afraid that our profession as a body does not sufficiently recognise its responsibility in regard to prognosis. When an individual submits himself for an opinion, he does so with such implicit confidence that the verdict given may alter the whole tenor of his life. He may, for instance, be seeking to enter some profession, when a preliminary medical examination reveals what the medical man takes to be an abnormality. An imperfect knowledge of its nature may, and unfortunately often does, lead to its being regarded as presaging possibly grave consequences, and the candidate is rejected. He is thus shut off from the prospect of his chosen calling, and, knowing the reason of his rejection, passes through life uneasily apprehensive of some impending disaster, whilst all the time the supposed abnormality may be a sign of little or no consequence.

If we look at an insurance form we realise the hardships to which applicants are exposed. "Is the pulse regular?" "Are the sounds of the heart pure?" "Is the urine free from albumen?" When such questions are answered in the negative the

applicant may nevertheless be perfectly healthy, yet is either rejected or is penalised for life by having to pay a higher premium, and, in addition, he is burdened with the consciousness of infirmity.

I dwell on this matter with some insistence, because I have known of so many instances in which gross injustice has been done to individuals not only from a pecuniary aspect, but in having imposed upon them great expense, unnecessary treatment, and mental disquiet, because the meaning and prognostic significance of some simple symptom had not been recognised.

A serious responsibility is thrown upon every practitioner at times in advising upon other questions. Should a man give up his business ? is a question upon which advice is constantly sought ; and whether the individual be a statesman or a labourer, the greatest care is necessary in formulating the answer. " Should a woman with some heart affection marry ? " or, " If she be pregnant, should the pregnancy be allowed to proceed ? " are problems that every general practitioner at one time or another will have to meet ; and if he seeks for guidance in the text-books he finds merely vague views which he cannot apply to the individual case. This fact alone should arrest the attention of the profession, and make it conscious how insufficient are the indications for an intelligent prognosis.

In estimating the value of any abnormal sign, or in determining the condition of the patient, a clear idea must be obtained of the mechanism by which any given symptom is produced, and of the effects that the underlying lesion has upon the

economy. It is impossible to give here indications that would be of value, partly because the subject traverses the whole field of clinical medicine and partly because I am not competent to deal with the matter, being only impressed with the importance of the subject and the necessity for its further consideration. So far as my experience goes, I can only say that one should never base a prognosis upon the presence of a single symptom, but should carefully investigate the effect of any abnormal sign on the functional efficiency of the organ and upon the economy as a whole. The presence of albumen in the urine is often a sign of variable import. In many cases it is a sign of great gravity, and this being recognised, it is too often regarded as being invariably a serious matter. It is now recognised that its significance depends on the conditions inducing it, and it may appear when there is no serious affection of the kidney, or when the kidney affection is of such a nature that it may have little effect upon the system. Cases of albuminuria should not therefore be hastily condemned until a complete review of the whole circumstances of the case, such as the history of the illness, the condition of the other constituents in the urine and their effect upon the circulatory system, has been made. In the same way the presence of a cardiac murmur or irregularity, or even an attack of angina pectoris, should never be considered as affording grounds for a grave prognosis until the whole circumstances of the case are taken into consideration. I mention these instances merely as indications as to what course to pursue when doubts arise as to the significance of any abnormal sign.

The symptoms which arise reflexly in like manner have to be carefully weighed. Intensity of suffering may have no relation to the gravity of the complaint. Toothache causes no anxiety as to the prognosis, though the immediate suffering is severe. Were the cause of the pain not so easily recognised the agonising distress would at times be viewed with the gravest anxiety. Extreme suffering from some trivial disease may be found among the symptoms of many organs. When it is recognised that the most agonising pains are associated with the contraction of non-striped muscular fibres, it will be realised that the cause inducing a contraction capable of calling forth violent pain may be of the most varied kinds, trivial as well as important. Even in the matter of angina pectoris the violence of the pain bears no necessary relation to the gravity of the heart complaint. In many cases the only sensation brought on by exhaustion of the heart muscle may be limited to a mere sense of constriction, and this, if properly appreciated, may indeed be the one sign which calls attention to the serious condition of the heart. I have repeatedly been consulted by elderly people for this sense of constriction across the chest when they exerted themselves, and in many cases it was the earliest symptom that heralded the termination of the patient's life. On the other hand, some of the most violent attacks of angina pectoris have occurred in people in whom the exhaustion of the heart was but temporary, and the restoration of reserve force resulted in a complete cessation of pain and in permanent recovery. Between these extremes there are many intermediate

forms, and it needs a careful inquiry into all the circumstances before a definite prognosis can be given.

In regard to the reflex phenomena the tendency to the exaggeration of symptoms by people with a hypersensitive nervous system must always be borne in mind.

136. The Bearing of Symptoms on Treatment.—The due appreciation of the mechanism by which symptoms are produced has a profound influence on treatment. It is often stated that treatment has to be symptomatic, that is, the symptoms are to be treated because the nature of the affection inducing those symptoms cannot be detected. Whole systems of treatment are based upon this idea, and though at times we may be forced to accept this line, it should always be done with regret at our incapacity to recognise the underlying cause of the suffering. A constant endeavour to make out the meaning of these symptoms, which have perforce to be treated without knowledge of their cause, will gradually diminish the number of patients who have to be treated symptomatically.

As pain is the most common complaint from which so many suffer, its relief is an aim of our treatment. But it should never be supposed that the assuagement of pain is the only object. It has become stereotyped to say "remove the cause," and if this advice had not become so much of a platitude more attention might be given to the "search for the cause." The recognition of the cause can only be attained in the majority of sufferers by a recognition of the mechanism by which the suffering is produced.

Recognising, for instance, that contraction of non-striped muscle produces a referred pain, the knowledge of how the pain is produced leads to the recognition of the hollow viscus producing it. There must be an abnormal stimulus exciting the muscle to contraction, and experience leads us to conclude what is the most common cause likely to produce the stimulation in a particular viscus. A pain with accompanying phenomena located in a certain region informs us that the stimulus arises from the gall-duct or the ureter. Experience tells us that a gall-stone or renal calculus is the most frequent cause. The absence of symptoms indicative of any other lesion confirms this view. On recognising that this is the cause, the question arises: Can we remove it? In the vast majority of cases this is only possible by surgical operation, and the question of the propriety of this procedure has to be considered. If, as is often the case, this proves inadvisable, then the treatment must proceed on other lines, and the recognition of the mechanism by which the pain arises again gives indications. As it is manifestly due to the strong contraction of non-striped muscle, measures that will relax the contraction of the muscle will naturally be the remedy in this particular case for the time being.

On the other hand, if the pain be aroused by some hollow muscular organ, where it is possible by simple means to remove the cause that stimulates the contraction, to this end treatment should be primarily directed. If, for instance, the indications point to the pain arising from painful peristalsis of the bowel, the inquiry will proceed to find out the probable nature of the stimulus. If

there has been a history of constipation, or incomplete evacuation of the bowel, the retention of scybalous masses is suggested as the cause of the peristalsis, and the treatment will be guided to measures that will lead to evacuation. So also with regard to any other viscus that can be emptied, the recognition of the nature of the symptoms affording the best guide for a rational and effective treatment.

In an organ, such as the heart, that cannot have the cause of the suffering removed by some mechanical process, the consideration of the conditions that induce the symptoms leads to a rational guide in treatment. As I have pointed out, any symptom of suffering points to an exhaustion of the reserve force, whatever be the nature of the functional exhaustion or structural lesion. The recognition of this indicates that treatment in the first instance must be directed to the restoration of this reserve force, and this can be done when consideration of the factors inducing the exhaustion are appreciated, such as over-work, worry, sleeplessness, or the hampering effect of some organic lesion. This demands careful investigation into the special features of each individual case.

These remarks may seem so evident as to be altogether unnecessary, as everyone recognises them. But though as a matter of theory they are the commonest of platitudes, as a matter of practice they are often neglected. If we consider the matter in relation to the treatment of heart affections, for instance, it would be found that, whatever the nature of the heart failure, a routine method of treatment is, with few exceptions, invariably

adopted. Thus heart failure is supposed to demand what are called "heart tonics," and the usual treatment is to prescribe the tonic which is dictated by the fancy or the physician or by the fashion of the day. In our inquiries into systems of treatment, such as are elaborated at places like Nauheim, it will be found that routine methods are employed, after few or no discriminating inquiries into the peculiar features of each case. One could indefinitely extend illustrations, drawn from other systems, where rule of thumb treatment is followed, to the neglect of the simple and obvious methods suggested by the careful appreciation of the meaning of symptoms.

I have already pointed out that treatment may be a factor in diagnosis—so-called diagnosis "ex juvantibus"—the manner in which symptoms react to treatment being often a useful help, as, for instance, the use of mercury or iodide of potassium in suspected cases of syphilis. But it is necessary also to appreciate when possible the manner in which the treatment acts. It must be the experience of everyone who has seen a large number of cases of stomach affections, that many cases of great suffering, where there is manifest structural lesion, obtain relief by some simple remedy or change in diet. Thus in pyloric stenosis with dilatation of the stomach the patient may have suffered for a long period, and some simple remedy, as bicarbonate of soda, may give instant relief and freedom from suffering for a long time. So also a change in the diet may have the same result. Too often such remarkable experiences are mistaken by physician and patient as evidences of the curative value and potency of the

drug or system of diet, and so we get the exaggerated praises of different drugs and systems so common nowadays. If it be recognised that some constituent was present in the stomach which occasioned the sufferings of the patient, and that the drug had neutralised its effects, or the change of diet had prevented its formation, it would have led to a truer appreciation of the benefits obtained by the treatment. It cannot be too strongly insisted upon that the reflex symptoms, which are those that are thus "cured," may arise, not from the actual lesion, but from a susceptibility to stimulation, or from some agent capable of inducing an adequate stimulation, and that the symptoms give no clue to the nature of the stimulation or to the agent causing it.

The recognition of the meaning of the reflex phenomena is of much use in so many ways that it is scarcely possible to do more than indicate certain phases of their value. The muscular contraction and hyperalgesia are always indications that some active process is going on. In cases of gastric ulcer, for instance, the treatment may have been so successful that the patient's sufferings are relieved and a "cure" is said to have resulted. But a careful examination of the left rectus muscle may reveal tenderness of its upper division with increased tone; and these symptoms indicate that the stomach lesion is still so active that it keeps up an irritable focus in the cord, and give indication that the treatment should be continued if a permanent recovery is to be attained. Occasionally one meets with cases where this viscero-motor reflex has been recognised and

taken as the factor needing treatment. In gall-stone disease, when there is present the tell-tale sign of contracted muscles in the epigastrium, energetic means, as baths, electricity, massage, are frequently employed to reduce the "hardness" of the belly wall!

The conception of the nature of the reflex phenomena may give a more direct aim to our therapeutic endeavours. I have already pointed out how the suffering in stomach affections may be due to the accidental presence of an agent that is capable of producing pain, and that remedies may neutralise the effect of the agent without modifying the disease process. It is conceivable that an effect may be produced in other ways, whereby treatment may influence the reflex symptoms at some portion of the chain between the lesion and the mental conception of the suffering. Thus a drug may act upon the muscular spasm when it causes pain, or it may act upon the spinal cord at the level where the visceral nerve stimulates the sensory nerve. It is just possible that it is here the relief is obtained in certain forms of counter-irritation. Thus I have seen a patient with a pyloric ulcer of the stomach obtain relief by a blister on the epigastrium over the limited area in which the pain was felt. This blister did not directly affect the ulcer, because the ulcer did not lie at the same level (*see* Fig. 16). Nor could one imagine that any reflex effect was produced in the ulcer itself. It seems more probable that the stimulus from the skin affecting directly the peripheral distribution of the sensory nerve prevented by some inhibiting process the stimulus from the viscus passing to the sensory cells in the spinal cord.

This seems the more reasonable, because it was found that on the healing of the blister the old pain from the ulcer returned, but if the blistered skin were kept raw by the application of some ointment the pain from the ulcer was subdued. This view receives support from the result of the researches of Sherrington, by which it has been shown that nerve paths may be stimulated from a variety of sources, but that of several contemporaneous stimuli one stimulus may be received and the others inhibited.

INDEX.

INDEX.

A

ABDOMINAL
tumour,178, 205.
wall, 63, 203, 205, 273.

ABSCESS
in lung, 213.
subphrenic, 216.

ADAMS-STOKES
syndrome, 262.

ADHESIONS
after operation, 204.
peritoneal, 175, 203.
parietal, 203.
visceral, 205.

AERATION
of blood, 214
tissues in heart disease, 211.

AFFECTIONS
of anus, 175.
bladder, 192.
circulatory system, 222.
digestive organs, 114.
female pelvic organs, 196.
intestines, 166.
kidney, 180, 266.
liver, etc., 155.
lungs, 207.
mouth and fauces, 122.
ovaries, 198.
pelvis of kidney, 182.
perineum, 175.
pleura, 207, 217.
stomach, 130.
ureter, 182.
urinary system, 180.
uterus, 197.
vagina, 199.

AIR-HUNGER, 208.

AIR-SUCTION
in stomach, 141.

ALBUMINURIA, 180, 181, 266.

ALCOHOLIC
gastric catarrh, 122.
morning sickness, 140.

ANGINA PECTORIS, 88, 100, 124, 235, 239, 240 (fig), 243 (fig), 254, 261.
cause, 254.

ANOREXIA, 119.

ANUS
affections of, 175.
nerve-supply, 115.

AORTIC
dilatation, case, 245.
disease, facial aspect, 107.

APPEARANCE OF PATIENTS, 104.

APPENDICITIS, 5, 100, 171, 204.

APPETITE, 118.
perverted, 120.

AREAS
of cutaneous hyperalgesia
in angina pectoris, 240, 243.
dilatation of heart and liver, 67, 238.
diaphragmatic pleurisy, 219.
gall-stone colic, 157.
gastric ulcer, 75.
peritonitis, 202.
pneumonia, 220.
renal colic, 185, 191.
of eruption in herpes zoster, 241.
pain. *See* "PAIN."

ARTERIO-SCLEROSIS, 249.

ASTHENIA,
neuro-muscular, 90.

ASTHMA, 99, 210.
cardiac, 99, 232.

ATONIC DYSPEPSIA, 144.

AURICULAR FIBRILLATION, 162, 250

AUTONOMIC
nerves, diagram, 59.
nervous system, 58, 114.

B

BACKACHE, 180.

BISMUTH
in intestines, 167.

BLADDER
affections of, 192.
calculus in, 186, 193.
development, 192.
functional symptoms, 195.
irritation of, 193.
nerve-supply, 192.
over-distension, 194.
pain in, 118.
secretion, 195.
structural symptoms, 196.

BLOOD
aeration of, 208, 214.
in fæces, 177.
heart disease, 211.

BOULIMIA, 120.

BOWELS. *See* "INTESTINES."

BREATHERS
mouth-, 126.

BREATHLESSNESS, 230.

BRONCHITIS,
expectoration in, 216

C

CALCULUS
in bladder, 186, 193.
renal. *See* "COLIC, RENAL."
ureteral, site of, 184, 186.

CAMPBELL
on herpes zoster, 127.

CANCER
of liver, 165.
stomach, 140, 142, 147, 257.

CARDIAC
asthma, 99, 232.
condition, facial aspect, 107.
irregularity, 263, 266.
murmur, 6, 94, 113, 226, 266.
pain, 88.
reflexes, 100.
valvular imperfection, 94, 225, 242, 258.

CASE REPORTED
of adhesive mediastinitis, 247.
angina pectoris, 242, 244, 245, 247, 248, 250, 253.
aortic dilatation, 245.
appendicitis, 171.
atheroma, 248, 250, 252, 253.
auricular fibrillation, 250.
calculus, renal, 187, 188, 190.
cardiac rupture, 253.
cardiac valvular disease, 242, 258.
enlargement of heart, 247.
fibrous myocarditis, 248.
gastric ulcer, 148, 149, 150, 152, 154, 258.
mediastinitis, adhesive, 247.

CASE REPORTED—*continued.*
of perforation of gastric ulcer, 148, 149, 150, 152, 154, 202.
peritonitis, 202.
pyloric stenosis, 205.
renal calculus.
colic. *See* "COLIC."
rupture of heart, 253.
stomach affections, series, 135.
ulcer, gastric. *See* "GASTRIC."

CEREBRO-SPINAL
nervous system, 58, 115.

CHEYNE-STOKES
respiration, 232.

CHLOROFORM
parturition, 177.

CHLOROSIS
facial aspect, 108.

CHOLANGITIS, 161.

CHOLERA
stools, 178.

CIRCULATION
affections of, 222.
enquiry concerning, 112.

CIRRHOSIS
of liver, 165.

CLINICAL OBSERVATION, 22.

CLINICAL TRAINING, 25.

CLASSIFICATION OF DISEASE.
anatomical, 40.
clinical, 42.

CLASSIFICATION OF SYMPTOMS, 40.

COLIC
appendicular, 173.
gall-stone, 133, 136, 156, 203.
intestinal, 117.
-like pains, 117.
renal, 82, 106, 118, 183, 185, 187, 188, 190.

COMPLEXION, 107, 163, 215.

CONDITION
of organs, 112.
patient, general, 109.

CONJUNCTIVITIS, 11.

CONSCIOUSNESS
of heart's action, 228.

CONTRACTION
of heart-muscle, 256.
muscles, 78.
non-striped muscle, 183, 267, 269.
stomach, hourglass, 145.
uterus, 197.

COOK
on swallowing fluids, 128.

COUGH, 212.

CRAMP
of stomach, 136, 159.

CREMASTER
muscle, 183.

CURES
value of, 272.

CUTANEOUS. *See* "SKIN."

D

DEVELOPMENT
of appendix, 175.
bladder, 192.
liver, etc., 155.
tunica vaginalis, 70.

DIAGNOSIS, 2.
of intestinal affections, 166.
stomach affections, 145.
treatment as a factor in, 271.

DIAPHRAGMATIC PLEURISY, 219 (fig.), 220.

DIARRHŒA
facial aspect, 108.

DIARRHŒIC
stools, 178.

DIETS, 145.

DIGESTIVE
organs, affections of, 114.
system, inquiry into, 112.
tract, areas of pain, 116.
functional symptoms, 177.
nerve-supply, 114.
sensory symptoms, 115.

DIGITALIS, 8

DILATATION
of aorta, case, 245.
heart and liver, 236, 238 (fig.).
stomach, 113, 140, 143, 147.

DIPHTHERIA, 5.

DISEASE
classification of, anatomical, 40.
clinical, 42.
definition of, 11.
detection of, 13.

DRUGS, 7.

DUSKINESS
of skin, 107, 215.

DYSPEPSIA, 158.
atonic, 144.

DYSPNŒA, 98, 211.

E

EAR
herpes zoster on, 127.

EFFORT SYNDROME, 90.

EMPHYSEMA
liver in, 165.

ENEMA
pain of, 71.

EPIGASTRIC
blister, 152, 273.
nerve supply, 134.
pain, 116, 135.
reflex, 138.

EPILEPSY, 262.

EUSTACHIAN TUBE
sensation in, 125.

EXAMINATION
of patient, 50, 104.

EXHAUSTION, 27, 82.
effect on symptoms, 260.
of heart, 87, 90, 224, 229, 232, 267.

EXPECTORATION, 215.

EXTRA-SYSTOLE
of heart, 135, 227, 230, 237.
cough in, 213, 230.

F

FACIAL ASPECT
in liver affections, 107, 163.
respiratory affections, 215.
of patients, 107, 215.

FÆCES
examination of, 177.
impacted, 170.

FAUCES
affections of, 122.
in swallowing, 127.
nerve supply, 115.

FEMALE
pelvic organs, 196.

FIBRILLATION, AURICULAR, 162, 250.

FEVER
in gall-stone disease, 161.

FISSURE
of anus, 176.

FLATULENCE, 141.

FOCI
in spinal cord, irritable, 132, 257

FOOD
pain after, 133, 137.
retention in stomach, 144.

FUNCTIONAL SYMPTOMS, 45.
of bladder, 195.
digestive tube, 177.
gall-stone disease, 160.
kidney, 181.
liver, 163.
respiratory affections, 214.
stomach, 142.

FUNCTIONS
of stomach, 131.
heart muscle, 254.

FURRED TONGUE, 126.

G

GALL-BLADDER, 155.

GALL-STONE
colic, 133, 136, 156.
pain, 106, 118, 156.
in shoulder, 106, 158.

GALL-STONE DISEASE, 147.
confused with appendicitis, 173.
facial aspect, 107.
fever in, 161.
functional symptoms, 160.
gastric symptoms, 136, 158.
reflex symptoms, 156, 273.
structural symptoms, 160.
taken for pleurisy, 159.
treatment, 273.

GASTRIC
catarrh of alcoholics, 122.
symptoms in gall-stone disease, 136, 158.

GASTRIC—*continued.*
ulcer, 132, 137, 145, 203, 258, 272.
perforation, 148, 149, 202.
pain in, 74, 137, 147, *et seq.*
site of pain, 147, 149 (fig.), 151 (fig.), 153 (fig.), 202.
treatment, 273.
vomiting in, 139, 140.

GASTRITIS, 132, 140, 159.

GENERAL CONDITION
of patient, 109.

GEOPHAGY, 120.

GOOSE-SKIN, 102.

GRAVES' DISEASE
facial aspect, 108.

H

HÆMORRHOIDS, 175.

HALDANE
on air-hunger, 208.
respiratory trouble, 211.

HALLER
on insensitiveness of viscera, 65.

HEAD
on herpes zoster, 127.

HEART
action, consciousness of, 228.
affections, 222.
auricular fibrillation, 150, 162.
-block, 135, 262.
dilatation, 236, 238 (fig.).
enlargement, 247.
exhaustion, 87, 90, 224, 229, 232, 267.
extra-systole, 135, 217, 230, 237.
failure, 223, 271.
facial aspect, 107.
enlarged liver, 162, 164.
inquiry into condition, 112.
irregularities, 113, 263.
-muscle, 254.
pain in, 254.
response to stimuli, 85, 87.
rupture, 253.
soldier's, 89.
spasm, 254.
treatment, 271.
valvular imperfection, 94, 225, 242, 258.

HEART-BURN, 128, 134, 140, 158.

HEPATOPTOSIS, 165.

HERNIA
mistaken for hydrocele, 70.
strangulated, 169.

HERPES ZOSTER, 241, 242.
in tonsilitis, 127.

HIRST
on swallowing fluids, 128.

HUNGER, 121.
Air-, 208.

HYDATIDS
of liver, 165, 216.

HYPERALGESIA, 257, 260.
cutaneous, 80.
areas of, 84.
(figs.) 67, 75, 157, 185, 191, 219, 238, 240, 243.
in affections of respiration, 218.
circulatory system, 234, 243, 258.
gall-bladder and duct, 157, 203.
intestines, 169.
liver, 67.
ovary, 199.
stomach, 75, 138, 202, 258.
angina pectoris, 239, 240, 243.
dilatation of heart, 238, 239.
obstruction of bowel, 170.
peritonitis, 202.
pleurisy, 218.
pneumonia, 220.
muscular, 63, 67 (fig.), 80, 160, 203, 218.
of testicle, 70.

HYPERCHLORHYDRIA, 137, 140.

HYSTERIA, 260.

I

ICE
pain of swallowing, 135.

INDIGESTION, 132, 257.

INFANTILE DIARRHŒA
stools, 178.

INSENSITIVENESS
of viscera. *See* "SENSIBILITY OR SENSITIVENESS."

INSURANCE
examination for, 264.

INTESTINES
affections of, 166.
obstruction, 140, 168, 180.
pain in, 117 (fig.), 168.
peristalsis of, 72, 117, 167, 168, 173.

IRREGULARITIES
of heart, 113, 263.

IRRITABLE FOCI
in spinal cord, 132, 257.

IRRITABLE HEART OF SOLDIERS, 89, 94.

J

JAUNDICE, 107, 160, 163.

K

KIDNEY
affections of, 180, 266.
calculus. *See* "COLIC, RENAL."
movable, 182.
nerve supply, 182, 186, 189.
-pelvis and ureter, 182.

L

LABORATORY OBSERVATION, 22, 37.

LABOUR
uterus during, 197.

LANGLEY
on dilatation of pupil, 103.
's diagram of autonomic nerves, 59, 114.

LARYNX, 212.

LAW OF ASSOCIATED PHENOMENA, 36, 92.

LAW OF PROGRESSION, 35.

LIVER, 155.
area of pain in affections of, 67 (fig.).
enlarged, 20, 161, 164.
in heart failure, 162, 164, 236, 238 (fig.).
facial aspect in affections of, 107, 163.
nerve supply, 155.
painful, 20, 161.
symptoms, functional, 163.
reflex, 162.
structural, 164.

LOCALISATION
of pain, 75, 106, 135, 147, 167, 169, 184.
renal calculus, 184.
sensation, 51.

LUNG
affection of, 207.
condition, inquiry into, 112.
crepitations at base, 232.
stasis or œdema, 232.

M

MALARIAL CACHEXIA
facial aspect, 107.

MALIGNANT DISEASE
facial aspect, 107.
of stomach, 140, 142, 147, 257.
simulated by liver affections, 164.

MALINGERING, 260.

MARRIS
on toxins, 51.

MAYLARD
on peritoneal adhesion, 204.

MEDIASTINITIS
adhesive, 247.

MERYCISM, 140.

MICTURITION, 112, 171, 176, 180, 193.

MISCARRIAGE, 198.

MORNING SICKNESS, 139.

MOTOR REFLEX, 53.

MOUTH
affections of, 122.
breathers, 126.
nerve-supply, 115.

MURMUR, CARDIAC, 6, 94, 113.

MUSCLES
abdominal, hard contracted, 78, 203, 273.
simulating tumour, 205.
contraction of, 78.
cremaster, 183.
heart-, 254.
intercostal, 218, 248.
levator palati, 127.
non-striped, 183, 267, 269.
of respiration, 209.
rectus, 133, 139.

MUSCULAR
hyperalgesia, 63, 67 (fig.), 80, 110, 203, 218.
layer of body wall, sensitiveness of, 63, 203.
rheumatism, 220, 249.

N

NAUHEIM TREATMENT, 271.

NAUSEA, 121.

NERVES
cerebro-spinal, to digestive tract, 115.
chorda tympani, 115.
cranial, fifth, 115, 123.
genito-crural, 186.
glosso-pharyngeal, 115.
laryngeal, 212.
of taste, 115.
olfactory, 115.
phrenic, 156, 219 (fig.), 221.
stimulation of, 103, 274.
sympathetic to stomach, 133.
thoracic, 53, 134, 241 (fig.).
vagus, 133, 134, 156, 252.

NERVE-SUPPLY
in appendicitis, 172.
of anus, 175.
bladder, 192.
digestive tract, 114.
epigastrium, 134.
gall-bladder, 155.
kidney, 182, 186, 189.
larynx, 212.
liver, etc., 155.
oral orifice, 115.
ovaries, 198.
perineum, 176.
pleura, 219.
respiratory muscles, 209.
stomach, 133.
ureter, 182, 186, 189,
vagina, 196.

NERVOUS SYSTEM,
autonomic, 58, 59 (fig.), 114.
cerebro-spinal, 58.
constitution, 58.

NEURALGIA, 123.

NEURASTHENIA. *See* "NEUROTIC."

NEURITIS, 158.

NEUROSIS, WAR, 91.

NEUROTIC
temperament, etc., 109, 141, 182, 229, 257, 258.

O

OBSERVATION
accuracy of, 20.
clinical and laboratory, 22.

OBSTRUCTION
of intestines, 140, 168.
pyloric, 140, 144, 205.

ŒDEMA
pulmonary, 232.

ŒSOPHAGEAL PAIN, 117.
area of, 116.

ŒSOPHAGUS, 128.
nerve-supply, 115.
stricture of, 129.

ORAL ORIFICE
nerve-supply, 115.

ORGANIC REFLEXES, 97, 253.

ORGANS
digestive, affections of, 114.
female pelvic, affections of, 196.
review of, 110.
sensibility of, 65.

ORTHOPNŒA, 231.

OVARIES, 198.

OVARIAN TUMOURS, 206.

OVARY
operation on, 113.

P

PAIN, 27.
after food, 133, 137.
colic-like, 117.
definition of, 57
in angina pectoris, 239, 240, 243.
appendicitis, 171.
bladder, 118.
diaphragmatic pleurisy, 219.
digestive tract, 116 (fig.).
gall-stone disease, 118, 156.
gastric ulcer. *See* "GASTRIC ULCER."
heart affections, 254.
intestine, 117, 168.
liver, 66.
movable kidney, 182.
œsophagus, 117, 128.
ovarian trouble, 198.
peristalsis of intestine, 72, 117, 168.
pleurisy, 208, 218, 219 (fig.).
pneumonia, 220.
renal colic. *See* "COLIC, RENAL."
shoulder, 106, 158, 219, 221.
stomach, 117, 134, 135, 137, 147.
testicle, 68, 82, 106, 183, 186.
tunica vaginalis, 69.
ureter, 184, 186.
uterine labour, 197.
uterus, 118.
vagina, 199.
localisation of, 75, 106, 135, 147, 167, 169, 184.
radiation of, 52, 55.
referred, 176, 182, 192, 197.
relief of, 268.
sensitiveness of tissues to, 61.
visceral, 15, 68, 118.
artificial production, 71.
mechanism, 74.

PALATAL MUSCLES, 127.

PALLOR
of face, 108.

PALPITATION, 229.

PARTURITION
perineal reflex, 176.

PATIENT
appearance, 104.
examination, 104.
facial aspect, 107.
general condition, 109.
sensations, 105, 207.

PELVIC ORGANS
female, 196.

PELVIS OF KIDNEY
affections of, 182.

PERFORATION
of stomach, 148, 149, 150, 152, 154, 202.

PERINEAL REFLEX, 176.

PERINEUM, 175.
torn, 176.

PERISTALSIS
of intestine, 72, 117, 167, 168, 173.
œsophagus, 129.
stomach, 134, 137, 140.
ureter, 82, 184, 186.

PERITONEAL ADHESIONS, 175, 201.
parietal, 203.
visceral, 205.

PERITONEUM
sensitiveness of, 64, 201.

PERITONITIS, 64, 171, 201.

PERNICIOUS ANÆMIA
facial aspect, 107.

PHRENIC NERVE, 156, 219, 221.

PHTHISIS
cough, 213.
expectoration, 216.

PILES, 175.

PILO-MOTOR REFLEX, 102.

PLEURA
affections of, 207, 217.

PLEURISY, 217.
and gall-stone disease, 159.
cough in, 213.
diaphragmatic, area of pain, 219 (fig.), 220.
effect on liver, 165.

PNEUMONIA
cough, 213.
expectoration, 216.
facial aspect, 108.
pain, 220.
stools, 178.

POLYURIA, 253.

PREGNANCY
vomiting in, 139, 199.

PREGNANT UTERUS, 197.

PROGNOSIS, 4, 37, 263.

PULMONARY
apoplexy, expectoration, 216.
condition, facial aspect, 107, 215.
œdema, 232.
stasis, 232.

PULSE
irregular, 227.
observation of, 25.

PYLORIC STENOSIS, 140, 144, 205.

PYROSIS, 140.

R

RADIATION IN DISEASE, 55.

RAMSTRÖM
on histology of abdominal wall, 64, 203.

RAYNAUD'S DISEASE, 102.

RECTUM
ulceration of, 176.

RECTUS MUSCLE, 133, 139.

REFLEX
cardiac, 100.
epigastric, 138.
motor, 53.
organic, 97, 253.
perineal, 176.
pilo-motor, 102.
secretory, 99.
skin or superficial, 138.
symptoms, 48, 132, 156, 159, 162, 172, 176, 193, 199, 212, 234, 257.
vaso-motor, 102.
viscero-motor, 77, 139, 234, 248.
viscero-sensory, 74, 234, 236, 239.

REFLEXES
in angina pectoris, 235.
appendicitis, 172.
gall-stone disease, 156.
kidney affections, 180.
liver affections, 162.
parturition, 176.
respiratory affections, 212.
stomach affections, 138.
visceral disease, 74, 81 (fig.).

REGURGITATION
from stomach, 128, 134, 140.

REMOTE EFFECTS
of lesion, 259.

RENAL
calculus
colic. *See* "COLIC, RENAL."
nerve-supply. *See* "NERVE-SUPPLY."

RESEARCH, 9, 17.

RESISTANCE TO STIMULATION, 84.

RESPIRATION, 209.
Cheyne-Stokes, 232.
with failing heart, 201, 232.

RETENTION
of food in stomach, 144.
urine, 176, 193.

RHEUMATISM, 158, 220, 249.

RIGIDITY
protective, 78.

S

SALIVA
flow in angina pectoris, 253.

SCHLESINGER
on swallowing fluids, 128.

SECRETIONS
of bladder, 196.
respiratory tract, 213, 215.
stomach, 142.

SECRETORY REFLEXES, 99.

SENSATION
radiation of, 52, 54.

SENSATIONS
in affections of lungs and pleura, 207.
of patient, 105.

SENSIBILITY OR SENSITIVENESS
of female pelvic organs, 196.
muscular layer of body-wall, 63.
organs, 65.
peritoneum, 64, 201.
pleura, 217.
tissues, 61.
viscera, 62.

SHERRINGTON, PROFESSOR
on radiation of pain, 52.
stimulation of nerves, 103, 274.

SHOULDER-PAIN, 106, 158, 210, 219 (fig.), 221.

SICKNESS
morning, alcoholic, 140.

SITE OF PAIN. *See* "AREA," and "LOCALISATION."

SKIN
duskiness, 107, 215.
goose-, 102.
hyperalgesia. *See* "HYPERALGESIA."
-reflex, 138.
sensibility, in, 62.

SNEEZING, 214.

SOLDIER'S HEART, 89, 94.

SPASM
in swallowing, 129.
of the heart, 254.
intercostal nucleus, 248.

SPINAL
cord, irritable foci, 132, 257.

STASIS
pulmonary, 232.

STENOSIS
of cardiac valves, 242.
pyloric, 140, 144, 205.

STIMULATION
mechanism of, 51.
resistance to, 84.
sensitiveness to, 61.
threshold of, 85.

STIMULI
summation of, as cause of angina pectoris, 254.

STOMACH
affections of, 130.
irritable focus in, 132.
reflexes in, 138.
cancer of, 140, 142, 147, 257.
constriction of, 145.
cramp, 136, 159.
diagnosis, 145.
dilatation of, 113, 140, 143, 147.
functions, 131.
functional symptoms, 142.
hyperalgesia from, 138.
malignant disease, 140, 142, 147, 257.
nerve-supply, 133.
pain, areas, 117, 134, 135, 137, 147.
pain with gall-stone colic, 106.
perforation, 148, 149, 150, 152, 154.
peristalsis, 134, 137, 140.
pyloric stenosis, 140, 144, 205.
regurgitation from, 128, 134, 137, 140.
retention of food, 144.
secretion, 142.
structural symptoms, 144.
treatment, 145, 271.
tumour, 144.
ulcer. *See* "GASTRIC ULCER."

STONE
in bladder
kidney
See "CALCULUS."

STOOLS
character of, 178.

STRICTURE
of œsophagus, 129.

STRUCTURAL SYMPTOMS, 43.
of bladder, 196.
digestive tube, 178.
gall-stone disease, 160.
kidneys, 181.
liver affections, 164.
respiratory affections, 217.
stomach affections, 144.

SUFFOCATION
sense in heart affections, 233

SWALLOWING, 127.
hot and cold fluids, 128.
ice, pain in, 135.
in angina pectoris, 124.
painful, 125.
spasm in, 129.

SYMPATHETIC NERVES. *See* "AUTONOMIC."
to stomach, 133.

SYMPTOMS
bearing on prognosis, 263.
treatment, 268.
classification of, 33.
definition of, 14.
differentiation of, 31.
functional, 20. *See* "FUNCTIONAL."
mechanism of, 92.
methods of investigation of, 14.
of affections of organs. *See* "AFFECTIONS."
reflex. *See* "REFLEX."
relation of, 256, 262.
sensory, in digestive tract, 115.
structural. *See* "STRUCTURAL."
value of, 256.

SYSTEM, NERVOUS. *See* "NERVOUS."

T

TACHYCARDIA, 162, 230, 236.

TEETH
false, inflammation from, 125.

TEMPERAMENTS, 109.
neurotic, 109, 141, 229, 257, 258.

TESTICULAR PAIN, 68.
in renal colic, 82, 106, 183, 186.

TIC DOULOUREUX, 123.

TONGUE, 126.

TONSILITIS, 127.

TONSILS
inflamed, 124.
in swallowing, 127.

TOOTHACHE, 55, 122, 267.

TREATMENT, 7.
as factor in diagnosis, 271.
bearing on symptoms on, 268.
of affections of heart, 271.
stomach, 145, 271.

TRIGEMINAL NEURALGIA, 123.

TUMOUR
abdominal, 178, 205.
in stomach, 144.
ovarian, 206.

TUNICA VAGINALIS, 69.

TYPHOID FEVER
facial aspect, 108.
stools, 178.

U

ULCER
gastric. *See* "GASTRIC."

ULCERATION
of pelvis of kidney, 184.
rectum, 176.
ureter, 184.

UMBILICAL FISTULA
pain in operation for, 72.

URETHRAL CARUNCLE, 200.

URETER
affections of, 182.
nerve-supply, 182, 186, 189.
peristalsis, 184, 186.
site of stone in, 184, 186.

URINARY SYSTEM
affections of, 180.
inquiry into, 112.

URINE
albumen in, 180, 181, 266.
retention of, 193.
secretion, in angina pectoris, 253.

UTERUS, 197.
pain in, 118, 196, 197.

V

VAGINA, 199.
nerve-supply, 196.

VAGUS NERVE, 133, 134, 156, 252.

VALUE
of symptoms, 256.

VALVULAR IMPERFECTION
of heart, 94, 225, 242, 258.

VASO-MOTOR REFLEXES, 102.

VISCERA
hollow, pain in, 118.
insensitiveness of, 65.

VISCERAL
disease, cutaneous hyperalgesia, 84.
pain in, 74.
pain, 15, 68, 118.
artificial production, 71.
mechanism of, 74.
reflexes, 74, 81 (fig.).

VISCERO-MOTOR REFLEX, 77, 139, 234, 248.

VISCERO-SENSORY REFLEX, 74, 234, 236, 239.

VOMITING, 82, 98, 139, 163, 199.

W

WAR NEUROSIS, 91.

WATER-BRASH, 140.

WILSON, R.M., 89
on toxins, 51.

X

X-RAYS
in examination of digestive tract, 143, 167.

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APPENDIX.

THE THEORY OF DISTURBED REFLEXES IN THE PRODUCTION OF SYMPTOMS OF DISEASE.

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WHEN we started the Institute for Clinical Research in St. Andrews we recognised that if success were to attend our efforts we must have a clear comprehension of our object, and a definite idea how that object should be attained. We define our object as the

Prevention of the Diseases that are Common amongst the People.

To understand how disease should be prevented it was necessary to know what are the diseases which are common among the people. On inquiry it was found that, except in a small percentage of cases, this knowledge was nowhere to be obtained.

Here, then, the first step to be taken was to know what the diseases are which we wished to prevent.

The next question was how to proceed to get this knowledge. The great majority of the sick suffered from complaints, and showed signs of ill health, but the disease was unknown. In a few cases the disease could be recognised, because medical knowledge had advanced so far as to detect certain signs and symptoms which experience had shown to be due to definite causes. Seeing that the diseases we wished to prevent were for the most part unrecognisable, it would be futile to attempt to prevent them, so that it was manifest an undertaking must start with preliminary inquiry into the nature of the diseases.

Definition of Disease.

In order that our inquiry should be pursued in a logical and systematic manner, we sought to get a clear grasp of what we meant by disease. The definition of an abstract term such as disease would probably be given in different terms, according to the standpoint of the definer. After much consideration and discussion we analysed the phenomena in over 1,000 cases and worked out the following scheme, which revealed the present state of knowledge on the subject, and at the same time afforded a guide for our inquiry.

If we take a simple disease like conjunctivitis, where the cause can be ascertained, we find that the diseased state consists of a foreign body which injuriously affects the tissues, causing certain reactions or symptoms, as pain, lacrymation, redness, blepharospasm. Such a condition may be considered a complete diagnosis and can be represented by the diagram (Fig. 1), where A is the injurious agent and the surrounding circles are the reactions or symptoms.

FIG. 1.

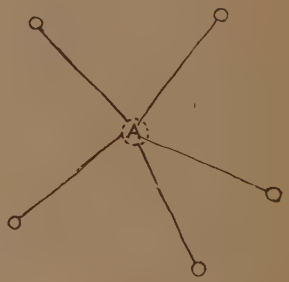

FIG. 2.

FIG. 1 represents a disease completely diagnosed, where A is the agent acting injuriously on the tissues and producing reactions or symptoms, which are represented by the circles at the periphery –as typhoid fever, or conjunctivitis due to a foreign body in the eye.

FIG. 2 represents a disease not fully diagnosed, where, while the symptoms are recognised, the injurious agent A has not been recognised, though its nature can be inferred, as in measles.

We found in our inquiry that the complete diagnosis is possible only in a relatively few cases—where the injurious agent has been recognised as due to a foreign body or to a microbe, as in typhoid fever, pneumonia, diphtheria.

In some cases the reactions occur in such definite groups that they can be differentiated, and it can be assumed with reasonable

certainty that the disease is caused also by a microbe which has not yet been identified, as measles, small-pox, rabies, etc. These are represented in Fig. 2, in which the injurious agent is represented by a dotted ring.

There were other cases in which the group of symptoms were also capable of differentiation, but in which the nature of the injurious agent was unknown, or a matter of speculation, as in migraine, epilepsy, diabetes, etc. This is represented in Fig. 3 where a point of interrogation represents the injurious agent.

The bulk of patients suffer from diseases in which, so far, it has been found impossible either to recognise the agent or to arrange the symptoms into groups that permit of their clear differentiation from others that they resemble. The nomenclature of such conditions is usually based on the presence of a dominant symptom or of a number of symptoms associated with some organ, auch as anaemia, neuralgia, neurasthenia, debility, disordered action of the heart, indigestion. The knowledge of the disease in those cases may be represented diagrammatically (Fig. 4) as a confused heap of symptoms in which it is not possible to obtain a suggestion as to their relation to a common cause.

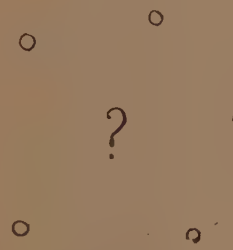

Fig. 3.

Fig. 4.

Fig. 3 represents a disease with a well-defined group of symptoms, but where the nature of the agent is not recognised—as migraine, convulsions.

Fig. 4 represents the vast majority of diseases, where a number of unco-ordinated symptoms are present with no recognisable cause.

To the latter group belong probably all chronic diseases, even though the ill health is definitely due to damaged organs which can be recognised by physical signs—as arterio-sclerosis, chronic heart disease, chronic kidney disease, and even consumption and cancer. The reason for including these is that they are probably secondary diseases, the original cause not being capable of recognition.

The Relation of Symptoms to Disease.

This method of looking upon disease reveals not only the state of our knowledge of diagnosis, but gives a guide in research. It shows that disease is only revealed by the symptoms it produces, and that even in the few diseases where the nature of the agent is understood it can only be identified in the human body by its symptoms.

A consideration of the history of the recognisable diseases shows that the first step in research is to recognise the symptoms. The next step is to group them together, so that one group can be clearly differentiated from those that resemble it. By this method the clinical observer differentiates the disease, it may be, without recognising the cause. Having reached this stage, he can present a clear-cut problem to, for example, the bacteriologist, who may complete the diagnosis by discovering the injurious agent. The symptoms of the majority of diseases have not yet been clearly differentiated, and there is little prospect of progress being made until this has been done.

This brief review of our present knowledge of disease shows that the chief aim of medical science—the prevention of disease—can never be achieved till we are able to recognise the diseases. Where success has been achieved and disease prevented, it was due in the first instance to the recognition of the symptoms. The clinical observer who obtained this knowledge succeeded because the symptoms were striking in character and easily recognised—as by the presence of a rash or eruption or other sign. It is reasonable to conclude that if we had a better understanding of the mechanism by which less obtrusive symptoms are produced we would get nearer to the detection of the agent producing them. When a person falls ill, the fact is made evident only by the symptoms, so that the only way in which the disease can be detected is by the recognition of symptoms.

The study of symptoms has been carried on since the dawn of medicine, and from the early days additions have continually been made to their numbers, until to-day the number is so great that no one individual can recognise more than a fraction of them, and methods are ever being invented for the discovery of new symptoms. If our enterprise were but to seek for new symptoms, it would be in vain, for the addition of new symptoms would but add to the confusion of a subject already far too chaotic.

The Evolution of a Science.

All subjects that have attained the position of a science have passed through stages of which the collection of facts was the first. So long as these facts were unco-ordinated their accumulation tended to confusion, and there came to be recognised the need for an ordered arrangement based upon a law of nature.

The history of chemistry is an illustration. The appreciation of Dalton's atomic theory gradually enabled the mass of detail to be classified according to a law of nature. Not only this, but it opened up possibilities and gave guidance to further research, and so enabled the science of chemistry to make remarkable progress.

Symptomatology is in the same confused state as chemistry was before the recognition of the atomic theory; and it calls as urgently for a classification based upon some law of nature that reveals the mechanism of the production of symptoms.

The Classification of Symptoms.

Hitherto there has been no clear conception of the nature of symptoms, and the classifications that have been made have hampered progress and misdirected the course of research. Thus symptoms are usually described from the standpoint of the organ giving rise to them, and specialists devote themselves to the study of the symptoms of individual organs or systems. When a person falls ill nearly every organ of the body may be disturbed, and each specialist has no difficulty in detecting symptoms belonging to his particular branch. In consequence of this we find that confusion of diagnosis which results when a patient consults a number of specialists.

Another source of error arises from the fact that when one organ is diseased its impaired function is revealed not by the organ at fault but by its effects upon the other organs of the body.

It is now many years since I saw the need for a knowledge of the mechanism by which symptoms were produced. I have steadily pursued the subject, and several years ago I dimly recognised that there was some definite law governing this mechanism. I attempted a classification and I was able to group a number of symptoms according to their mechanism, such as a *structural group*, recognised by a physical sign, a *functional group* due to interference with the functions of an organ, and a *reflex group*, due to the peculiar stimulus setting up definite reactions. But there remained a large group, which I recognised somehow or other belonged to the last group, but their mechanism was not clear.

This was the state of knowledge when we began our inquiry. We recognised that it was useless to attempt a research into any particular disease until we had acquired a knowledge of the laws that underlay the production of symptoms, and to that end our chief endeavour was given. We met twice a week; at one meeting we discussed the nature of one particular symptom, and sought for an explanation in the daily routine of examining patients. At the other weekly meeting we discussed in detail the symptoms of individual patients.

The Law Governing the Production of Symptoms.

As time went on we got a better insight into one symptom after another, and we felt we were getting nearer the law of which we were in search, and gradually its recognition dawned upon us. At first we scarcely recognised it when it was put before us because of its extreme simplicity, for we found the law to be *that the vast majority of the symptoms of disease are disturbances of normal reflexes.*

I know quite well that no one who reads this will accept at present the view that this theory will do for clinical medicine what the atomic theory did for chemistry, but I know equally well that when the method of applying it is understood its significance will be appreciated, and it will have a very far-reaching influence on the progress of medicine.

How the Theory was Discovered.

The discovery of this law is the outcome of a long and painstaking search with a definite object in view.

Shortly after entering general practice, over forty years ago, I was impressed with my ignorance of the diseases from which my patients suffered. In the majority the evidence of ill health was confined to the patient's sensations, which I could not interpret. Realising this, I resolved to see if I could not improve my knowledge, and began to pay more attention to such signs as I could detect, and the principal sensations of which the patient complained. I had not gone far when I realised that these signs and symptoms were so numerous that I could only hope to investigate a limited number. But even when I had selected a few for particular observation I did not know what method to pursue. On reflection I decided upon concentrating my attention on two aspects: (1) *The mechanism by which a symptom was produced*; and (2) *the bearing the cause of the symptom had on the patient's future.*

Of these aspects the latter is, of course, of the utmost practical value to a doctor, and although under the term "prognosis" it

has received perfunctory attention, I found that neither the manner in which the subject should be studied nor the individual whose opportunities fitted him for the task had been realised; but with that I do not deal here.

The study of the mechanism by which symptoms were produced led me into several different fields. There was, for instance, the pulsatile movements in the jugular veins and the liver, the movements of the heart in health and disease, and the mechanism of irregular heart action to be considered. I devoted several years to finding out the mechanism of these signs, and the results were an ample reward for the labour and time spent, and helped to make that revolution which has made of human cardiology a totally different subject from what it was when these researches were begun.

The study of the sensations of the patient was much more difficult. I began with the most clamant of all—pain. Hilton's book on *Rest and Pain* was the furthest step that had been taken, but valuable as it was it did not go to the root of the matter. For some years I made little progress—collecting isolated facts but unable to see any reasonable explanation for their causation. In 1888 Dr. James Ross published his article on referred pain, and I at once recognised that he had provided a hypothesis which not only helped to explain much that was obscure but gave a guide for carrying the subject further. In this paper he stated that pain, when arising in an organ, was felt in two ways—first by a pain in the organ itself, and second by the pain felt in the external body wall at a place remote from the organ. The first of these he called splanchnic and the second he called somatic.

I had already gone so far in my inquiry that I recognised the significance of his somatic or referred pain, but I was doubtful of his splanchnic, considering that it also was really referred. He used as an illustration the pain of gastric ulcer when limited to the epigastrium as being a splanchnic pain, but when I examined a patient with a gastric ulcer I found that on a deep inspiration, while the stomach descended, the pain remained fixed.

Though suggestive this was far from convincing, and I sought diligently for other signs, and in 1891 I found a sign which threw much light upon the matter. This was finding a large area of hyperalgesia of the skin over the liver in a patient after an attack of gall-stone colic. This led me to seek for cutaneous hyperalgesia in other cases, and I soon found that it was of frequent occurrence, particularly in affections of abdominal organs. It required, however, a long training to acquire the skill to detect it in many cases.

Shortly after this another sign was recognised—namely, the contraction of the muscles of the abdominal wall, due to disease of an abdominal organ. It had been recognised before, and spoken of as "protective rigidity," but its real nature and significance had never been understood. I watched how portions of the muscle wall of the abdomen would become hard and resistant during the course of a disease, such as gastric ulcer, appendicitis, gall-stone disease, cholecystitis. I observed it disappear with improvement, until it was not evident, and I could recall it by gently rubbing over it. I noted in patients the sudden contraction of muscle that ensued under certain conditions. Thus, some of my patients described that on the onset of an attack of renal colic the testicle would be dragged up (by contraction of the cremaster muscle).

I described these symptoms of pain and hyperalgesia in consequence of disease of the viscera as a *viscero-sensory reflex*, and the contraction of the muscle as a *viscero-motor reflex*.

There was a large group of symptoms which occurred when patients fell ill from some obscure cause (as infection), such as the feeling of exhaustion, loss of appetite, breathlessness on exertion, palpitation, vomiting, mental depression. These had been vaguely described as toxic symptoms, and I had indeed described them as due to a hypersensitiveness of certain parts of the central nervous system, but I did not clearly realise the mechanism which produced them; this was the stage reached when we started the Clinical Institute, and the matter was summarised in an address I gave on the "Soldier's heart and war neurosis: a study in symptomatology."[1]

The Application of the Theory.

In the description of the theory and its application which follows, some simple observations are given to show the manner in which certain reflexes are disturbed; while we have found it already of value in the interpretation of our patients' symptoms, we recognise that there is required a much better knowledge of reflexes before the theory can be used in a systematic manner. The illustrations therefore are merely to indicate how it may become of use.

While the stimulus and response parts of a reflex may often be recognised, the mechanism of that part of the reflex in the central nervous system is not yet quite clear. Consequently the diagrams of this part of the reflex do not pretend to represent the actual mechanism.

In attempting so to explain the theory that symptoms arise from disturbed reflexes as to carry conviction we recognise that we are handicapped in that what we take to be facts may not be

accepted as facts by the reader, and it would take up too much space and time to give our reasons. When, for instance, I state that exhaustion of heart muscle produces pain and proceed to develop the argument in which that statement is accepted as a fact, the reader may not accept the statement. The observations on which that statement is based have been carried on for many years, during which patients have been watched and the circumstances provoking the pain have been considered, the gradual progress of the case observed, and the conditions at the *post-mortem* examination carefully noted. Another long series of observations have been made to discover the laws that govern the production of pain in all muscular organs—a research, indeed, in which we are still engaged, and which every day tends to confirm the view advanced here. In like manner, when I take it as a fact that exhaustion is due to a disturbance of a vasomotor reflex, it is not possible to give the long series of observations on which the statement is based.

Until we are able to publish the researches into these and other matters involved in this description, I would ask the reader to assume that our facts are proven, so that the explanation of this theory may be understood.

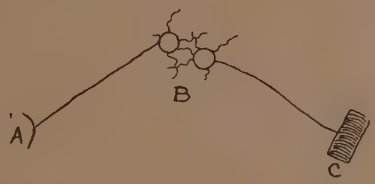

FIG. 5.—Diagram of a simple reflex arc. The stimulus affects the receptor A, from which a nerve passes to a nerve cell at B, where it joins another cell which sends an efferent fibre to C—the effector or structure which gives the response.

Description of a Reflex Arc.

In the reflex arc we recognise the following parts (Fig. 5). A, The receptor or place where the reflex is initiated. An afferent nerve fibre conducts the stimulus to B, the nerve centre. Here the afferent nerve ends in a synapse with one or more nerve cells—the actual number and relationship varying in complexity. The nerve centre in turn sends an efferent fibre to C—the effector or structure, be it muscle or gland or centre of consciousness, which gives the ultimate response characteristic of the reflex.

The whole of this arc is necessary for the production of a simple reflex. Symptoms, or, in other words, alterations in the

reflex, may be referable to causes acting upon any part of the arc, but in practice they are found to be mainly confined to alteration in A, the receptor; B, the nerve centre; or C, the effector.

The Part of the Reflex in Life.

The whole economy of the body is built up of a system of organs whose activities depend on reflexes. A flood of stimuli is continually being poured into the system through the skin and special senses, and each stimulus produces a definite reflex on some part of the body. In the deeper tissues of the body stimuli are continually arising and being sent to different organs, which respond by some modification of their activity.

The sources of stimulation, therefore, arise in every part of the body. Organs that at one time are the source of stimulation become at other times the effectors. Thus, when pain is felt, the source (A part of the reflex) may be the peripheral distribution of any sensory nerve, while the brain is the organ which responds (the C part of the reflex). The different organs of the body during periods of activity and quiescence send out stimuli-producing reflexes which modify the activities of other organs—as the heart when it increases its activity in responding to a call for more blood, or decreases its activity in a cessation of effort.

The interplay of these reflexes results in the harmonious action of the organs of the body which we recognise as "health." The disturbance of one or more of these reflexes results in a disharmony which we recognise as symptoms of disease.

Methods by which Disturbed Reflexes are Produced.

There are two ways in which reflexes may be disturbed:

1. By the nature of the stimulus acting on the A part of the reflex arc, the impulse entering through the nervous system.

2. By altering in a positive or negative sense the receptivity of the B and C parts of the reflex, the agent (chemical or thermic) entering through the blood stream.

Disturbance of Reflexes due to the Stimulus Entering through the Nervous System.

The following observations sufficiently illustrate the mechanism by which this kind of disturbed reflex is produced.

Many years ago I had shown that the only serous membrane in which a sensation of pain could be produced was the visceral layer of the tunica vaginalis.

Observation 1.

Dr. Orr, in tapping a hydrocele, tested this statement and noted the sensitiveness of the parietal and visceral layers of the tunica vaginalis. He found he could scratch the parietal layer and the patient feel nothing, but when he touched the visceral layer with the trocar the patient (1) drew back, (2) felt severe pain, (3) became pale, (4) nauseated, and (5) collapsed.

Observation 2.

A man was seized with an attack of renal colic and suffered violent pain in the left side of the abdomen, with contraction of the muscles. He became pale, and sweat poured out; he vomited, and the pulse became soft, and he felt faint.

In Observation 1 the touching of the visceral layer of the tunica vaginalis was the stimulus at the receptive or A part of the reflex. Then followed a variety of responses or effects on the C part of the reflex: (1) A muscular response in the sudden drawing back of the body; (2) the sensation of pain—the centre of consciousness being the response part of the reflex; (3) pallor—a cardiac reflex—due to a stimulation of the vagus, which also probably caused (4) the nausea, and (5) collapse, due to a vasomotor reaction. In Observation 2 we have a similar series of reflexes, these being in addition, the vasomotor reflex causing the sweating, and the vomiting reflex.

Alteration of the Receptivity of the B and C Parts of the Reflex Arc.

The other method, by altering the B and C portions of the reflex arc, comes about through the circulation in the blood of certain agents which affect parts of the arc in a negative or positive way—that is, either increasing or diminishing the intensity of the impulses during their passage from A to C.

The demonstration of the disturbance of the reflexes through the nervous system is readily understood from such observations as 1 and 2. The demonstration of the circulatory—chemical or toxic—influences is not so easy. Perhaps the best way is to consider the effects of certain drugs whose effects have been sufficiently observed.

Observation 3.—*The Effect of Atropine.*

An individual who receives a certain quantity of atropine may complain of impaired vision and palpitation. When examined he is found to have a dilated pupil and an increased heart rate, which is abnormally increased on effort.

Each of these effects is due to the drug blocking the passage of normal impulses at C. The pupil of the eye is maintained in an ever-varying balance between dilatation and contraction, responding with great sensitiveness to the stimulus of light. This is because of two reflexes, one presiding over the dilator muscles of the pupil and the other over the sphincter muscles. The atropine blocks the passage of the normal impulses to the sphincter at C and the balance is upset. The heart's activity is regulated in the same way by two sets of nerves, acceleration of rate by the sympathetic, and slowing of rate by the vagus. The heart is like the pupil, ever ready to respond to a demand for more or less blood from the tissues, according to their ever-varying activity. The atropine acts by paralysing the peripheral end of the vagus, or by depressing the C end of the reflex arc, and the uncontrolled sympathetic fibres cause the increased rate.

FIG. 6.—Diagram of a muscular reflex. The stimulus from A passes to B, where it affects the nerve cells supplying the muscles C and C′. In response to the stimulus the muscle at C contracts, while the muscle at C′ relaxes. The signs + and — indicate the different actions.

Observation 4.—The Action of Strychnine.

In the reflex action of muscles in causing the movement of a joint there occurs normally at the same time as the contraction of the muscles a relaxation of the opposing muscles. Thus in Fig. 6 the stimulus arising at A, is diverted at B to C, which causes a contraction of the muscle, and to C′, causing a relaxation of the muscle. These reactions are shown by + and —. The effect of strychnine in producing convulsions is by converting the inhibition of the muscles which takes place in a reflex movement of a joint into a contraction of these muscles, as in Fig. 7, where both reactions are seen, represented by + sign.

This observation shows the influence of an agent modifying the reflex at the B portion of the arc, and explains the mechanism of the convulsions in rabies as well as in strychnine poisoning. It is to be noted that neither the strychnine nor the toxin in rabies can by themselves initiate a stimulus for the production of a reflex—this arises always from some part of the body through the A portion of the reflex arc, as at the skin. This fact shows that

the drug does not cause convulsions, but only modifies the reflex in such a way that the stimulus from A produces the convulsions.

These methods of action probably explain the action of all drugs or toxins which are supposed to act on centres. A great number of drugs are credited with causing vomiting for instance, but the manner in which they act is to render the B or C portion of the arc more susceptible to a stimulus so that a normal stimulus passing into the nervous system affects certain reflexes which have been rendered unduly sensitive.

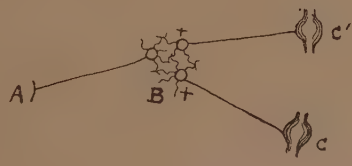

FIG. 7.—Diagram illustrating the effects of strychnine. The response from the stimulus arising at A affects the cells at B differently, so that while the muscle at C contracts the muscle at C′ does not relax, but also contracts. This is shown by the — sign in Fig. 6 being now a + sign.

The following observation shows how a normal act can affect the reflex at B when it is rendered hypersensitive by an agent such as a drug.

Observation 5.

A man with a regular heart, after I had given digitalis, showed irregularities which a graphic record demonstrated to be due to the dropping out of ventricular systoles, the auricular rhythm being unaffected. The digitalis was stopped, and in a few days the heart's rhythm became quite regular, the ventricular systoles having ceased to drop out. Commenting on this fact to the patient, he said he could bring the irregularity back, and I asked him how, and he replied, "By swallowing." I requested him to swallow, which he did, and a ventricular systole dropped out. I took a long tracing, and when he did not swallow the rhythm was regular, but as soon as he swallowed a beat was missed. This was repeated a great number of times. Four days later the heart was quite regular, and swallowing had no effect upon the heart's rate.

Observation 6.

A woman, aged 52, experiences attacks in which she becomes prostrated, suffers severe pain in the head, and vomits. If she lies quite still she does not vomit, but if she is startled by a noise—such as the banging of a door or ringing of a bell—or if she smells tobacco or cooking, vomiting occurs.

In this condition there is manifestly a hypersensitive condition of the B part of the reflex arc, but it is to be observed that vomiting occurs from a stimulus from the periphery, just as the convulsion in rabies and strychnine poisoning.

The Added or Reinforced Stimulation.

In the production of reflexes in disease the reflex often takes place with unusual ease or facility, a slight stimulus producing an exaggerated reflex or calling into play an unusual reflex, as in Observation 5. The reason for this is that the disease disturbs some parts of the reflex arc rendering them more or less susceptible to stimulation. This may happen in several ways.

In certain forms of visceral disease certain areas of the skin or other tissues of the external body wall show an increased susceptibility to stimulation. Thus, when pressure is applied to the skin of such a strength that in the unaffected part it produces only the sensation of touch or pressure, it produces in these hyperalgesic areas the sensation of pain. The explanation of this disturbance of the normal reflex is that already a stimulus is affecting the arc from the diseased organ A, and the added stimulus of pressure A′ is sufficient to produce pain (Fig. 8).

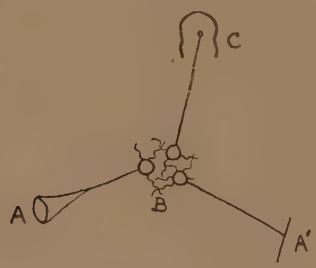

FIG. 8.—Diagram to illustrate an added or reinforced stimulus. The presence of disease at A (say gastric ulcer, a diseased tooth) keeps up a persistent irritation at B, so that a stimulus from A′ (the skin or other organ) not sufficient to cause pain by itself, affects the irritated cells at B and produces pain (see also Observations 5, 6, 7).

The contraction of the muscles of the abdominal wall in disease of abdominal organs (the "viscero-motor reflex") is but an exaggeration of the normal reflex which maintains the tone of these muscles. If the gradual disappearance of these contractions be observed it will be found to merge into that state of resistance which we recognise as tone in these muscles, so that the contraction in visceral diseases is but an exaggeration of the normal tone.

The increased sensitiveness which is shown by hyperalgesia of the tissues of the external body wall is capable of giving rise to pain from a stimulus reaching the central parts of the arc.

Observation 7.

A man with advanced aortic disease suffered from attacks of angina pectoris. He had a diseased tooth, which caused a slight degree of pain. During the attacks of angina pectoris, in addition to the pain in the chest and left arm he had pain along the jaw, but the pain was always most severe around the diseased tooth.

In this instance the diseased tooth kept up a continual irritation of the A part of the sensory reflex, and the pain would become more severe when pressure was made on it in chewing, the reflex arc being disturbed by an increase of the stimuli at A. During the attacks of angina pectoris pain was felt along the jaw—where there was already a disturbed reflex—this additional stimulus reaching the arc at B produced an increase of the pain, or in other words an increased response, at C.

Observation 8.

A man suffered from jaundice with severe attacks of gall-stone colic for several days. The skin of the upper part of the abdomen on the right side was very tender on pressure (hyperalgesia). The pains suddenly ceased and a gall stone the size of a bean was passed by the bowel. The hyperalgesia of the skin persisted, but he suffered pain over the hyperalgesic region on taking food. When the hyperalgesia disappeared he suffered no pain on taking food.

Here, as in Observation 5, a normal stimulus (resulting from the taking of food) on entrance into the central nervous system affected a hypersensitive part of a reflex.

Balanced Reflexes.

There are a great many different kinds of reflexes, some so obscure that their mechanism is not clear. There is one form which from its symplicity illustrates the theory of disturbed reflexes as the basis of symptoms. This is the kind which might be called balanced reflexes, where two systems of reflexes mutually react. This was seen in the description of the reflex contraction of muscles, when at the same time one set of muscles contracts another set relaxes, where strychnine and the toxins of rabies and of tetanus disturb this balance (Figs. 6 and 7). It is also shown in the pupil, where normally the movements of the pupil are exquisitely balanced by the nerves supplying the dilator and sphincter fibres, and where atropine upsets this balance by paralysing the sphincter fibres. It also occurs in the heart, where the play between the accelerator and depressor nerves of the heart results in the delicate regulation of the heart's activity in response to stimuli from the other organs of the body.

In many illnesses the balanced reflex is upset, so that we find the pulse rate a valuable indication of the patient's state. In most toxic cases the rate is increased, possibly by the excitation of the accelerator (sympathetic) part of the reflex. In some cases the toxin stimulates the depressor part, as in typhoid fever, and the effect upon this part of the balanced reflex is seen in certain diseases where the heart's rate becomes very slow, as in the following observation.

Observation 9.

A man 50 years of age began to suffer from sudden attacks of loss of consciousness of brief duration. His pulse was found to be slow, and records—graphic and electrographic—showed that his ventricle was responding only to every second auricular beat. As this is typical of one kind of an over-action of the vagus, an attempt was made to remove this by atropine, which paralyses the peripheral end of the vagus. A hypodermic injection of one-fiftieth of a grain of atropine was followed in ten minutes by the appearance of more beats, and in thirty-five minutes the ventricle responded to every auricular systole.

In this instance the disturbed reflex was due to an over-action of one part of the balanced reflex (the vagus) and the removal of this over-activity at the c portion of the arc by the atropine restored the heart to its normal rhythm.

An example of the disturbance of the balanced reflex, which not only illustrates the mechanism but throws light on a matter of real importance in practice, is afforded by the variation in the heart rate occasioned by the act of respiration. In differentiating the different forms of heart irregularity I recognised one form common in the young, which I called the youthful type of irregularity, and demonstrated that it was produced by the breathing; the heart increased in rate during inspiration and decreased during expiration. This variation was more marked if the individual breathed slowly and deeply.

On inquiring into the significance of this form of irregularity I found it present in young people in perfect health. I found it disappeared when any febrile illness caused an increase in the heart's rate, and it returned when the fever fell and the rate returned to normal. I have used this irregularity for over twenty years as a guide in doubtful cases after recovery from illness, looking upon its presence as a proof that the disease had departed, and that the heart was free from any active process. This view is now justified. Under ordinary circumstances the balance between the accelerator and depressor nerves is so even that a

stimulus such as breathing disturbs the balance. The presence of a toxic agent affects the reflex, causing an increase in the rate, so that the slight stimulation from the act of breathing no longer has any effect, and hence the reappearance of the irregularity at the termination of a febrile illness.

The Disturbed Part of the Response.

The tendency to heart-block by stimulating the vagus (as by the use of digitalis) is more apt to occur when the bundle connecting the auricle and ventricle is damaged, and the question arises, Is the effect at C which produces heart-block due to an increase of the vagal activity or an increased susceptibility of the responding organ—that is, the auriculo-ventricular bundle? That the reflex may be impaired by the diminished susceptibility of the recipient organ at C can be inferred from the following observation :

Observation 10.

A man 68 years of age consulted me because he had found that on making a considerable effort, as running upstairs, his pulse, in place of increasing in rate, fell to nearly one-half its rate. I tested him, and found that this was so ; I considered that the bundle which conveys the stimulus from auricle to ventricle was damaged, so that while the damaged bundle could convey a stimulus at the rate of 60 or 70 times a minute, it failed to do so when the rate became higher. Subsequent records, graphic and electrographic, confirmed this view.

In this instance the normal balance of the reflex between the augmenting and inhibiting nerves to the heart is disturbed by the damage to the recipient organ.

Multiple Stimuli and Multiple Responses.

The response at C may be due to stimuli originating at different places and in different ways. Thus an abdominal muscle may contract in response to a stimulus from the brain, or from the skin, or from the movements of respiration, or from the movements of the body, or from a visceral stimulus, as in Observation 2.

A single stimulus can give rise to a number of responses—indeed, most stimuli do ; we have seen that a cutaneous reflex giving rise to a movement of a joint does so by the contraction of one group of muscles and the inhibition of another group, while Observations 1 and 2 showed that in response to a stimulus a number of reflexes followed.

Multiple Reflexes.

During ill health the patient may complain of a number of symptoms, and the doctor may detect a number of signs. This is due to the fact that the agent which causes ill health disturbs a great many reflexes. To look at these signs and symptoms, each one recorded as an isolated fact, presents such a confused picture that a coherent description of the patient's condition cannot be given. When the individual reflexes are recognised, then the symptoms can be grouped upon a rational principle.

This plan of analysis can be employed in studying the reflexes produced by the impaired functions of organs, or by the specific reaction to the toxins of disease, as well as to drugs, in the manner already described.

The Disturbed Reflexes due to Organic Disease.

One essential question in cases of diseased organs is their functional efficiency. When all the organs are functioning in a normal manner the reflexes pass unnoticed by the individual. When a failure of function takes place the reflexes are disturbed and symptoms appear. It is difficult to recognise the real source of a reflex, for many organs when they fail to function in a normal fashion do not themselves show the signs of failure, but the signs are shown by other organs that are deprived of the material the erring organ contributes to the economy.

While the failure of each organ will give rise to different reflexes the fundamental principles governing the production of the symptom will be the same.

The Disturbed Reflexes due to Heart Failure.

The symptoms produced by heart failure offer a good illustration, as they have been worked out in some detail.

When a healthy individual engages in violent physical effort he will in time produce exhaustion of the heart, so that it no longer supplies sufficient blood to the organs and tissues, and the individual suffers distress. The same thing happens when an individual with a diseased heart undergoes an effort which leads to exhaustion, only in the second instance the amount of effort is less. The signs of heart failure are those of distress and are not to be found by the examination of the heart but by effects of an insufficient supply of blood to other organs. This is well recognised in advanced heart failure when there are in addition to distress on effort, the physical signs of dropsy and an enlarged liver.

In the great majority of people who suffer from heart failure these physical signs never appear. In them the heart failure is made manifest by a limitation in their response to effort; they are pulled up by distress in some effort they were wont to perform in comfort. This is because of certain reflexes that are set up by organs which suffer from an insufficient supply of blood. The reflexes are of a nature that produce distress of such a clamant kind that cessation of effort is called for. They are mainly of two kinds—the distress associated with (1) breathlessness and (2) pain in a distinctive region.

In healthy people the most frequent evidence of heart exhaustion (as in running) is breathlessness and the accompanying sensation of tightness at the throat and a sense of suffocation. Occasionally there is also a sensation of constriction of the chest with pain across the chest.

What happens in a healthy person is also what happens in one with a weak and diseased heart, one difference being that less effort produces the distress in the latter case and another that pain is a fairly frequent cause of distress.

The mechanism of these two reflexes is quite distinct. Respiratory distress is the outcome of a disturbance of the respiratory reflex on account of the heart being unable to supply purified blood to some part of the respiratory system. I do not discuss further this mechanism here, as it would lead us too far, but everyone recognises that breathlessness is a sign of heart exhaustion and that it is due to a disturbed reflex.

The other reflex, of which pain is the dominant feature, is a reflex arising from exhaustion of the heart muscle itself. The pain is often accompanied by other reflex signs, as contraction of the intercostal muscles producing the constriction of the chest—sometimes of such extreme violence as to be more dreaded than the pain. Sometimes the mouth fills with saliva, and the pain may be felt not only in the chest but in the arms and along the jaw (Observation 7). These are multiple reflexes comparable with that described in Observation 2.

Observation 11.

A man 68 years of age complains of breathlessness on going up a hill or stairs. Also of pain across the chest, on effort under certain conditions, such as walking out on a cold day or after a full meal. The pain across the chest is preceded by a sense of tightness, or constriction, such as used to pull him up when running a race in boyhood. These signs of limitation have come on gradually, and he noticed his limitation fifteen years ago. There are no physical signs of disease, except some arterial degeneration

This account is one common to a great many people, in whom the coronary arteries become diseased so that the heart muscle does not receive an adequate supply of blood.

In this case the heart in supplying the active muscles of the legs fails to supply other parts with enough blood, and amongst others the respiratory system is affected, and gives rise to the complex reflex which is called breathlessness. At other times the heart muscle does not receive a sufficient supply of blood, and it gives rise to its peculiar reflex—pain and contraction of the muscles of the chest wall.

In heart exhaustion, then, we have two prominent reflexes—the one arising from a deficient supply of blood to the respiratory organs, and the other arising from exhaustion of the heart muscle. Which of these reflexes first appears on heart exhaustion depends on whether the respiratory or cardiac reflex is first called into play. In the case quoted, under certain circumstances it was the respiratory, and under others it was pain. Occasionally they may both appear.

In certain cases the respiratory reflex is readily produced, as in auricular fibrillation—a condition in which pain is infrequent and rarely severe, while in diseases which limit the supply of blood to the heart muscles pain is readily induced. In the following instance the reaction of the reflex to the different heart states is brought out.

Observation 12.

A man 66 years of age consulted me for pain on walking. The pain at first was only produced by walking, and only on certain occasions—mostly on walking after a meal. The pain was situated across the chest, and was accompanied by a gripping sensation. As years passed the pain became so easily provoked that walking under any circumstances would cause it. The heart was normal in size and the rhythm of the heart normal. One day, when 72 years of age, he called to see me, and said that until recently he could walk 200 yards before the pain compelled him to stop. Now he can only walk 100 yards when he is pulled up, not by pain but by breathlessness. Indeed, since this breathlessness occurred he had not suffered from pain. On examination I found the heart was irregular in its action, the irregularity being characteristic of that due to auricular fibrillation.

This is not an isolated instance, as I have had several cases with a somewhat similar history, but explains an observation I made many years ago, that people with auricular fibrillation do not suffer from severe attacks of angina pectoris.

The Effects of Drugs.

It has already been shown that drugs act by causing a disturbance of reflexes. This way of looking at the action of drugs explains much that is obscure in pharmacology, as the following observation shows.

For a long time it was recognised that digitalis acted in a remarkable manner in some cases of rapid pulse in reducing the rate, while it had no effect in other cases. It was never understood why there should be this difference. I found out about fifteen years ago that in the cases in which it had this slowing effect the heart was regulated by abnormal rhythms—mainly that abnormal rhythm due to the condition now recognised as auricular fibrillation. I have attempted many times to reduce the increased rate of the heart when the rhythm was normal, and invariably failed. I speculated for a long time as to the cause of this difference, but never understood it till the theory of disturbed reflexes made the matter plain.

In infectious diseases—as pneumonia, measles, etc.—the balanced reflex that moderates the heart's action is disturbed by the toxins of the casual agent of disease, so that the rate of the whole heart is increased.

In auricular fibrillation this reflex is not disturbed. When the rhythm is normal the ventricle contracts only to the stimulus that arises from an auricular systole. In auricular fibrillation there is no rhythmic contraction of the auricle, but a continuous fibrillary twitching of the muscle, so that in place of the regular stimulus from the contracting auricle there is a shower of weak stimuli which assail the conducting system between auricle and ventricle, and cause the rapid ventricular rate. Not only is there this difference in the cause of the increased rate, but there is a difference in the condition of the cardiac reflex. In rapid pulse with the normal rhythm the reflex is disturbed by the toxins of the diseased state, so that the digitalis can produce no effect. In auricular fibrillation the reflex is unaffected, so that the digitalis can act upon the vagus portion, and in doing so depresses the conducting mechanism to the ventricle and renders it not so susceptible to the numerous stimuli from the auricle.

The Analysis of Symptoms.

In many diseases all the symptoms on which a diagnosis is based are reflex in origin—in some the reflexes are disturbed by the entrance of the stimulus through the nervous system, and in others the disturbance is through the circulation. To the former

belong the symptoms of such diseases as gastric ulcer, renal calculus, gall-stone disease, where the symptoms are of the type described in Observation 2. The symptoms in infections are due to the disturbance of the reflexes through the circulation, as influenza, malaria, typhoid and typhus fevers, measles, and abscess formation, apart from the swelling.

In some diseases we get a mixture of both kinds of reflexes, as in appendicitis, where there is not only the local pain and tenderness of the tissues of the external body wall, with contraction of the muscles of the abdomen, but the feeling of exhaustion, rapid pulse, tendency to vomit. In cholecystitis we get a similar complex.

The need for the more accurate recognition of symptoms is seen when it is considered how difficult it is to diagnose even such seemingly simple affections as gastric ulcer and appendicitis. Though surgeons have been operating for these complaints for many years, the most experienced recognise that in many cases they find they have been mistaken in their diagnosis. This is due in a great measure to the fact that the nature and mechanism of the symptoms of these diseases have never been understood, and the symptoms were never clearly differentiated from those of other diseases which they resemble.

It will thus be seen that symptomatology is like chemistry, where the combination of elements results in the production of a great number of compounds bewildering in their variety. Nevertheless, as in chemistry, when they are subjected to strict analysis they can be resolved into their component elements. When the analysis of symptoms is studied as fully as the analysis of chemical compounds have been studied, then it will be possible to group the disturbed reflexes in an orderly manner. The next step then will be to find out the agents capable of provoking the different reflexes, so that we get nearer to the immediate cause of disease.

The employment of this method of investigation is but a return to those methods of clinical research which were so fruitful in their results in the past, especially during the early half of the nineteenth century. To realise how great the progress was during that period we have to consider the discoveries associated with the names of Addison, Bright, Graves, Adams, Stokes, Cheyne, Paget, Hodgkin, and Jenner. These observers employed the most useful of all weapons in research—the trained senses. What we aim at is to recognise the methods which these great observers employed, and by improving and refining their methods restore clinical medicine to the van of research.

Structural and Functional Symptoms.

A certain number of symptoms are due to structural changes and functional derangements. These are generally shown by physical signs, and are due to departures from the normal in various ways, as in alteration in the size and shape and consistence of organs, changes in the colour, as pallor, modification of the sounds of the heart and lungs. These are not dealt with here, but will have to be reconsidered in view of this theory of disturbed reflexes, because many apparently structural and functional signs are really disturbed reflexes, or are produced by disturbed reflexes.

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